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# Water for Joliet

RIVER OF WATER RAISED FROM 1600-FT. WELLS BY AIR SOLVES CITY'S MOST IMPORTANT QUESTION

MILLIONS OF GALLONS of water are consumed daily by the citizens of Joliet, Ill., for domestic and industrial uses. To supply this water in sufficient quantity has been a serious problem for the city government to solve, and the history of the water works system is checkered with partial successes and complete failures until the present system of pumping was put into complete operation, since which time the water supply has been more than sufficient to meet the demands of the city with some of the wells held in reserve.

FIG. 2. AIR COMPRESSOR IN WASHINGTON ST. PLANT ILLUSTRATING TYPE USED THROUGHOUT SYSTEM

## SOURCE OF WATER

ALTHOUGH the Chicago drainage canal runs through the heart of the city, and it would be possible to purify this water for domestic use, the sentiment against this source of supply forbade its use, so the city is compelled to pump from artesian wells. The first available source of underground water is from the St. Peter stratum, which is 600 to 900 ft. below the surface, but this stratum does not give sufficient supply to warrant the cost of installation of machinery, and the next water vein is in the Potsdam stratum, which is 1600 ft. deep and the vein is 110 to 150 ft. thick. While somewhat high in sulphates, this water is tasteless, free from contamination and abundant in supply, rising to within 100 ft. of the ground when the pumps are not working.

In all, there are 10 wells running to the Potsdam stratum and located at widely separated points, in a general way encircling the principal section of the city.

The first 300 ft. of the wells are provided with 16-in. casing but below this, the bore is for the most part in solid rock and no casing is provided, except where caving in was imminent. How to bring the water from such a depth and deliver it into the mains against a pressure sufficient for the needs of the city, is the problem which has confronted the engineers in the water works department, and it is only since modern air-lift pumps have been installed that completely satisfactory results have been secured.

FIG. 1. PARTIAL MAP OF JOLIET WATER WORKS SYSTEM SHOWING LOCATION OF PUMPING PLANTS

The equipment which has been adopted as standard for the wells consists of a Harris air pump placed at the bottom end of a 6½-in. discharge pipe. The running submergence desired is 55 per cent, but at some wells it is 50 per cent. The average static head is 100 ft., and the recession 100 ft., making a working head on the air-lift pump of 200 ft. and the depth of the air-lift pump 450 ft. An auxiliary air line is placed at such a depth that no greater air pressure is needed for starting than for running. At most of the isolated plants the water is discharged through an umbrella head or reverse bend into a concrete weir box from which it is pumped by means of triplex pumps into the city mains.

At the main pumping station are 4 wells which discharge into reservoirs. The wells being located 300 to 350 ft. from the reservoirs, it is necessary to pipe the water horizontally from the wells and elevate it about 10 ft. from the top of the wells, so Harris boosters are employed here.

### Pumping Machinery

Machinery for pumping the water is divided among one main plant, on Washington St., and 6 isolated plants. Power for operating all the isolated plants is purchased from the Public Service corporation at a low rate, while at the main plant the air compressors are motor driven from purchased power, but the pumps are steam driven.

Compressed air for lifting the water at the main plant is furnished by 2 Ingersoll-Rand air compressors, each 22 and 13 by 16 in., compressing air in 2 stages to 100 lb. pressure. The air intake is through screened pipes from outdoors and the delivery is to individual receivers on the outside of the wall. From the receivers air is taken through a manifold to the wells. The compressors are driven by Westinghouse induction motors of 200 hp. each through a short drive belting arrangement.

FIG. 4. INLET AND OUTLET END OF PURIFYING RESERVOIR AT CANAL ST. PLANT

Several features of the Imperial XB compressor make it of particular value for this class of work, and consequently this type has been installed in all of the recently equipped plants of the system. Although distinctly in the duplex class, the main frame is a one-piece casting and carries all other parts, making the machine a solid and self-contained unit. The air cylinders, being bolted to the frame, are in no way dependent upon the foundation for correct alinement. The driving wheel, which also serves as a flywheel, is hung centrally with the machine, thus distributing the weight of the machine evenly over the foundation.

The duplex design gives balanced construction, with quartered cranks effecting an equalization of efforts and thus reduces structural stresses and gives easier duty on the belt. This type is easily compounded and at the pressure employed here, 100 lb., together with the intercooler which is provided, the economy of compression is comparatively high. The air cylinders are double acting and designed to give minimum clearance space and have the barrels and heads water jacketed. Intake valves are of the Corliss mechanically operated type worked from eccentrics on the shaft, while the discharge valves are of the direct lift spring loaded pattern.

For delivering water from the reservoirs to the mains, 2 pumps are provided. One of these is an old E. P. Allis rocker type pump which has a 3,000,000 gal. rating, the other is a Laidlaw-Dunn-Gordon compound duplex pump of like rating located in a pit. Only one of these pumps is used under normal circumstances, but the other is held in readiness for immediate use. Jet condensers are used with these pumps.

Steam for operating the pumps is generated in 5 boilers, two of which are Stirling water-tube, rated at 300 hp. each, the other 3 being Scotch marine, rated at 150 hp.; the steam pressure carried is 100 lb.

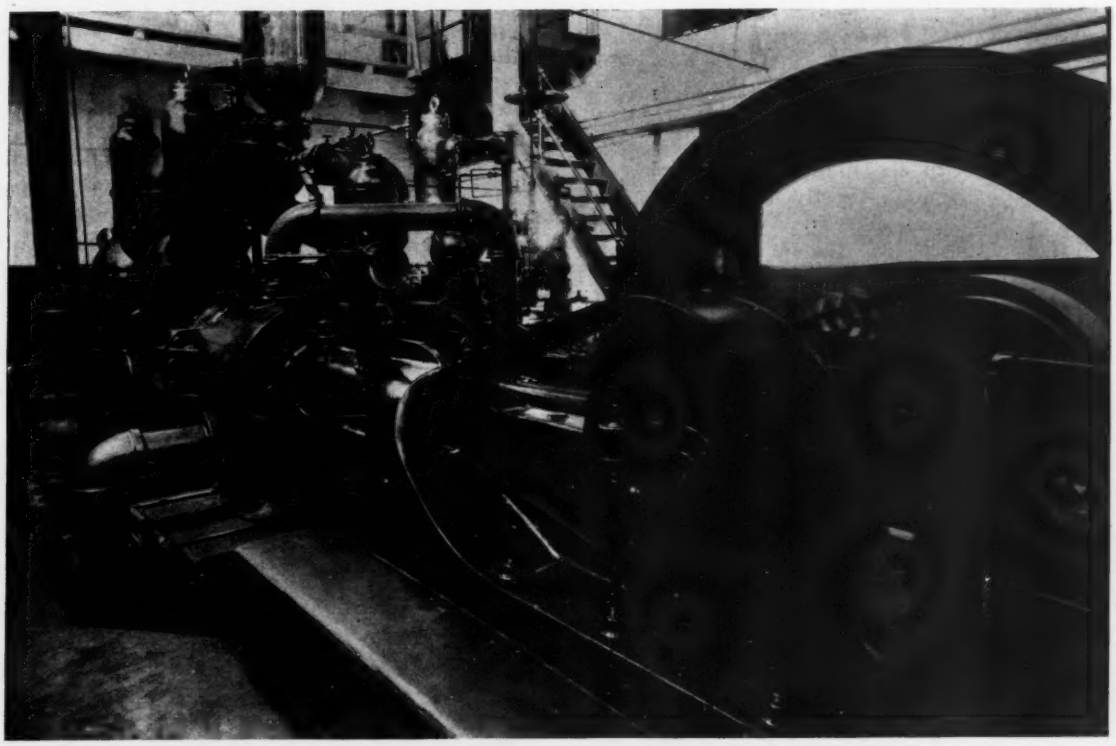


FIG. 3. LAIDLAW-DUNN-GORDON PUMP AT WASHINGTON ST. PLANT

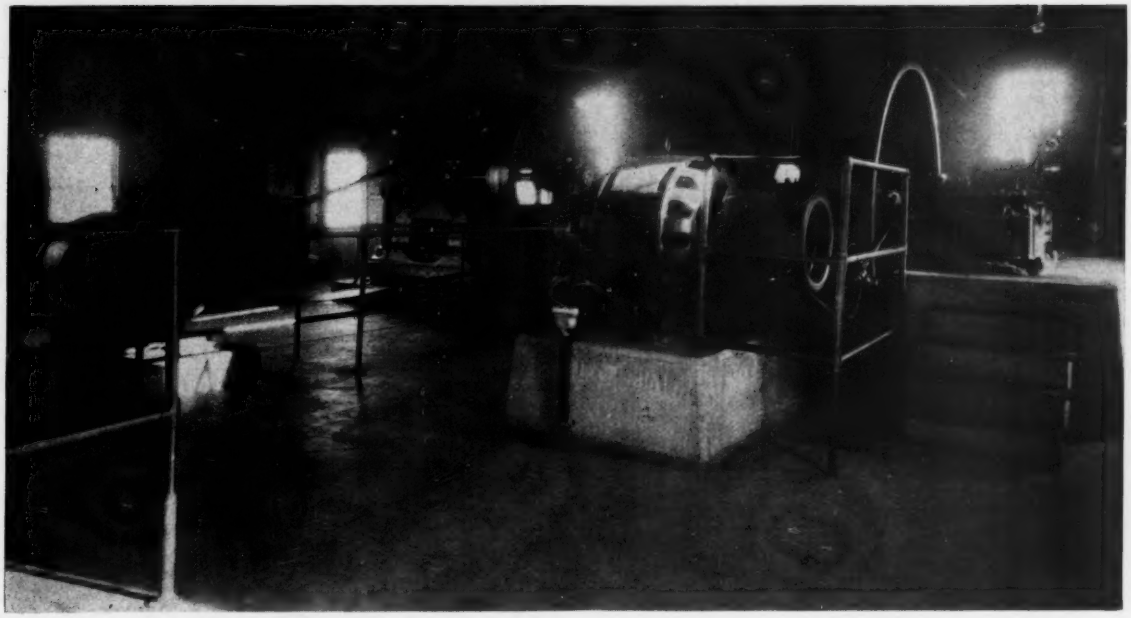


FIG. 5. INTERIOR VIEW OF RUBY ST. PLANT, WHICH IS TYPICAL OF OTHER ISOLATED PLANTS

At this plant are 2 reservoirs which receive the water direct from the wells and hold it in storage for night use, when the isolated plants are shut down, and emergency use as needed. One of the reservoirs is cir-

cular, 16½ ft. deep with a capacity of 1,000,000 U. S. gallons, the other is rectangular, 17 ft. deep with a capacity of 4,500,000 U. S. gallons. This supply is sufficient to run the city for 5½ to 6 days under normal circumstances. A pipe line from a quarry is provided to be used for supplying water in the extreme case of failure of the wells to supply the needs of the city. This discharges into the reservoir, but has not been used since the present system of pumping has been employed.

The Washington St. plant takes care of all peaks on the system and is in operation day and night. All pressure pumps discharge directly into the mains, but the pressure carried at different stations varies with the elevation of the plant. The piping system of the city is, however, divided into 2 sections, the east side which is at the lower level is carried at 35 lb. pressure, while the west side section supplies customers at a higher elevation and the pressure in the mains at the pumping

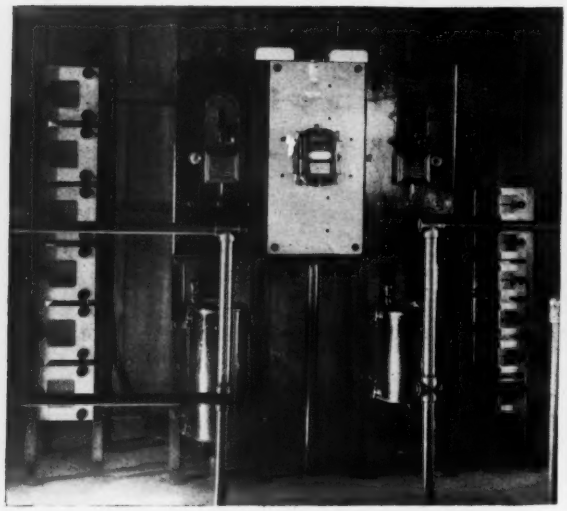


FIG. 6. SWITCHBOARD AT RUBY ST.

stations is 75 lb.; the minimum pressure at the highest elevations of the city is 25 lb. In case of fire, the pressure can be raised to 150 lb., for which pressure the pipe lines are designed.

To care for slight fluctuations in pressure due to variation in use of water, an elevated standpipe is located on a hill and connected with the west side system. This tank is supported by a steel tower 100 ft. above the ground and is 15 ft. in diameter by 30 ft. high with a capacity of 200,000 gal. The 2 sections are connected through a check valve which allows water to run from the east side to the west side when pressure in the west side becomes low.

Each isolated plant pumps from one well, the machinery consisting of a motor driven air compressor and a motor driven triplex plunger pump.

At the Ottawa St. plant, water is delivered at the rate of 1,000,000 gal. in 24 hr. Air is compressed by a Laidlaw-Dunn-Gordon 2-stage compressor to 90 lb. pressure and the water is delivered to the mains by a Deane of Holyoke triplex pump. One 200-hp. motor drives both machines through belt connections.

The Canal St. well has a capacity of 900,000 gal. in 24 hr. and the machinery here consists of a Laidlaw-Dunn-Gordon compressor and Deane of Holyoke pump driven by individual motors. At this plant, the water from the well is slightly contaminated with oil and gas, presumably from a gas plant nearby. Although every possible precaution was taken to prevent water from upper strata from getting into the well, the trouble still existed and to overcome the trouble the city engineer, C. D. O'Callahan, devised a scheme for aerating the water which has eliminated all objections to the water.

Water from the well is discharged over steps and descends into a concrete reservoir 75 ft. long by 20 ft. wide and 7 ft. deep. This is divided into compartments of about 7 ft. each with a center wall passing longitudinally through the reservoir. The partitions forming the several compartments in the reservoir act as baffles, the water passing over one and under the next one and so on up one side and back on the other, the partition in the center forming virtually 2 reservoirs.

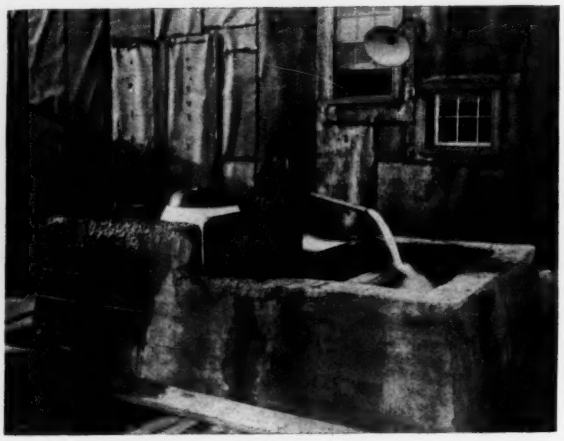


FIG. 7. UMBRELLA DISCHARGE HEAD AND WEIR AT RUBY ST. SMALL PIPE IS DISCHARGING COOLING WATER FROM CYLINDERS AND INTERCOOLER

A system of pipes is laid leading into each compartment of the reservoir, which were perforated and rested upon the bottom of the reservoir. Air is delivered through these pipes to each compartment at low pressure, allowing the air to bubble up to the surface, causing little agitation at the surface of the water. A considerable amount of oil and grease collected on the sides of the first compartment in the reservoir which receives the water after it passes down the steps. Small amounts were also collected in the next and succeeding compartments, but by the time the water reaches the last compartment no oil appears on the surface and the odor of gas is entirely eliminated.

At the time of the last test, the Desplaines St. well delivered water at the rate of 500,000 gal. in 24 hr. The equipment here is an Ingersoll-Rand compressor and a Goulds triplex pump run by belts from individual motors.

An Ingersoll-Rand compressor and a Goulds triplex pump with individual motor drive are installed in the Spruce Slip plant. When last measured, this well was yielding water at the rate of 540,000 gal. in 24 hr.

At the Van Buren St. well a Laidlaw-Dunn-Gordon air compressor and a Deane triplex pump are driven by individual motors, the flow of water at the last measurement was at the rate of 540,000 gal. in 24 hr.

The most recent plant of the system is at the Ruby St. well. Here an Ingersoll-Rand compressor and a Goulds triplex pump driven by individual motors are the principal machines. The switchboard equipment at this plant is the standard which has been chosen for future installations and consists of 3 panels upon which are mounted 2 circuit breakers and a polyphase watt-hour meter, 2 controllers and 2 rheostats complete the equipment, all of which was made by the Westinghouse company. This well yields at the rate of 1,500,000 gal. in 24 hr., the air compressor being driven by a 150-hp. motor and the running head against which the water is raised is 250 ft.

The water works department of the city employs a meter testing corps which keeps the meters in proper condition by checking the readings against the weight of water passed through them. Customers are charged at the rate of 20 cents per 100 cu. ft. with a minimum of $1.50 a quarter. This rate, which has but recently been put into effect, is higher than formerly and it is thought will put the water works department on a self sustaining basis.

An interesting recommendation of the city engineer to the City Council is, that a plant be adapted for pumping water from the canal into a high-pressure system for fire service in the business district. This would not only reduce the fire insurance rates but conserve the artesian water supply.

# Coal Handling in a Small Plant

PRACTICAL, INEXPENSIVE APPLIANCES FOR HANDLING COAL WITH LEAST AMOUNT OF LABOR. BY R. A. LANGWORTHY

IT IS NOT the intention of this article to cover the entire field of handling coal for the power plant; to do so would require a volume. Neither is it the intention to deal with large power plants, as they usually have ample money and engineering talent available to solve the problem. It might be remarked in passing that it is at times a question in studying some of the larger plant installations, whether a simple and less expensive system would not have been equally effective.

In this article the writer will endeavor to illustrate a few simple, cheap and effective methods of handling the coal in plants of 2500 to 3000 hp. and less. When the average man studies the various catalogs of the manufacturers, in an endeavor to select for his plant a system which is within reach of his pocketbook, he is apt to give up finally in disgust. He will find many large and expensive schemes pictured and described, principally showing the way to do the work in hand, but not with a minimum expenditure.

It is a simple matter to pick out a system which will handle coal, but to lay out one which is low in first cost and does not require excessive maintenance usually requires careful study. It is easy to spend a considerable amount of money on the coal handling system without getting adequate return on the investment. Another point to be borne in mind is that a complicated system usually requires high grade labor to maintain it, which may be difficult to spare for this work in the small plant.

The method used in some plants is to shovel by hand from the coal cars into a pile, and then handle it to the firing floor in wheelbarrows. This requires small investment, but the labor will be entirely too high if any quantity of coal is used. It is difficult to keep an accurate record of the coal burned with this method, as "juggling" the records is simple.

### TRESTLE DUMP SYSTEM

ONE of the best schemes, where the plant location allows of its use, is illustrated in Fig. 1. The trestle may be of either wood construction, or steel beams on concrete piers. The coal is dumped from hopper bottom cars and requires little handling to the firing floor. It gives a fair amount of storage and the operating cost is very small, but this plan cannot be used where the coal requires crushing.

A modification sometimes used is to bring the overhead track into the building, and dump directly onto the firing floor, which requires a larger building and limits the storage. Figure 1 is applicable only to a single line of boilers, while with the track inside the boiler room it may be applied to a double row. The principal disad-

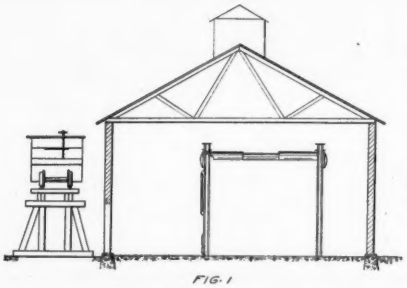



FIG. 1. TRESTLE FOR DUMPING COAL AND DIRECT WHEELBARROW OR SMALL TRAMCAR HANDLING TO BOILERS

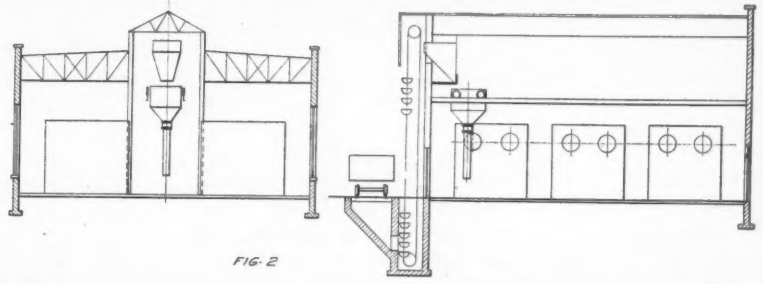



FIG. 2. DUMPING PIT AND HOPPER WITH BUCKET LIFT AND TRAVELING LARRY

vantage of this plan is the lack of proper facilities for weighing and recording the coal burned.

### Ground Track Dump and Bucket Lift

A good system which may be installed at reasonable expense is shown in Fig. 2. A concrete hopper and pit, placed under the siding track, discharge into an elevating bucket conveyor, which dumps the coal into a small overhead bin, and this in turn feeds a traveling larry for distributing it to the firing floor, or stokers. Where a coal crusher is needed, it may be installed beneath the track hopper. The larry may be provided with an automatic scale to record the coal used. This system requires little labor for its operation, and the maintenance expense is moderate, but only a small amount of storage is available. The scheme can be modified to cost less by replacing the traveling larry with hand cars in the boiler room floor on a track, which should contain a scale with automatic counter. The car system would probably require more labor and space than the larry.

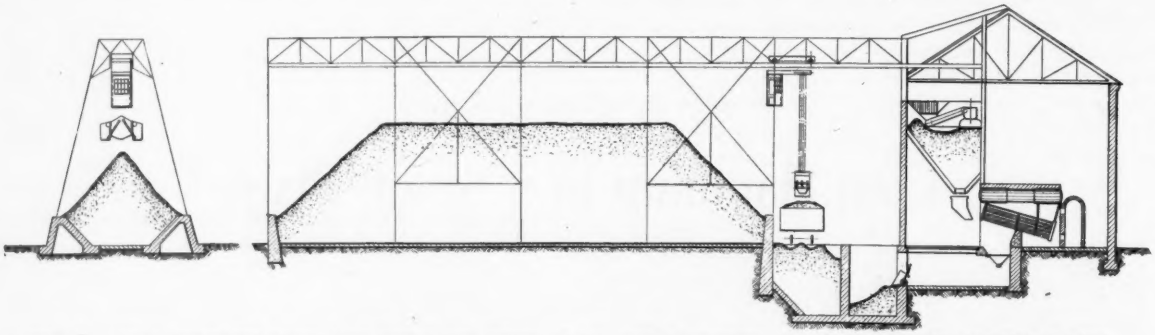


FIG. 3. COAL STORAGE YARD AND DUMP PIT WITH CLAM SHELL BUCKET, TRAVELING CRANE, OVERHEAD BINS AND ASH DUMP PIT

### Coal Storage with Crane Bucket for Coal and Ash Handling

Figure 3 shows a combined coal and ash handling system with coal storage which may be installed at a moderate cost for the larger plants. It consists of an electrically propelled overhead traveler with a clam shell bucket. The bucket takes the coal from the track hopper, the cars or the storage pile, and delivers it to an overhead bin. If needed, a crusher is installed over the bin, which discharges into the traveling overhead larry that feeds the firing floor or stoker hoppers. Ashes are dumped into large barrows and wheeled by hand to the ash hopper just outside the building. From this hopper they are taken by the clam shell bucket and delivered to cars or wagons for disposal.

This system is moderate in first cost, requires a reasonably small amount of labor, and can be maintained economically. As installed in a 4000-hp. plant, it required, to operate the bucket and crusher, one man, who also had time to make most of the smaller repairs to the apparatus; and one man to dump and wheel ashes. The larry was operated by the fireman. A considerable amount of storage can be obtained at small expense, if the ground is available, by extending the storage bin and overhead runway. A modification of this scheme would be to run the overhead traveler parallel to the boiler room wall, supporting one of the rails on pilasters built into the wall, and with hoppers to the overhead bin extending outside the building.

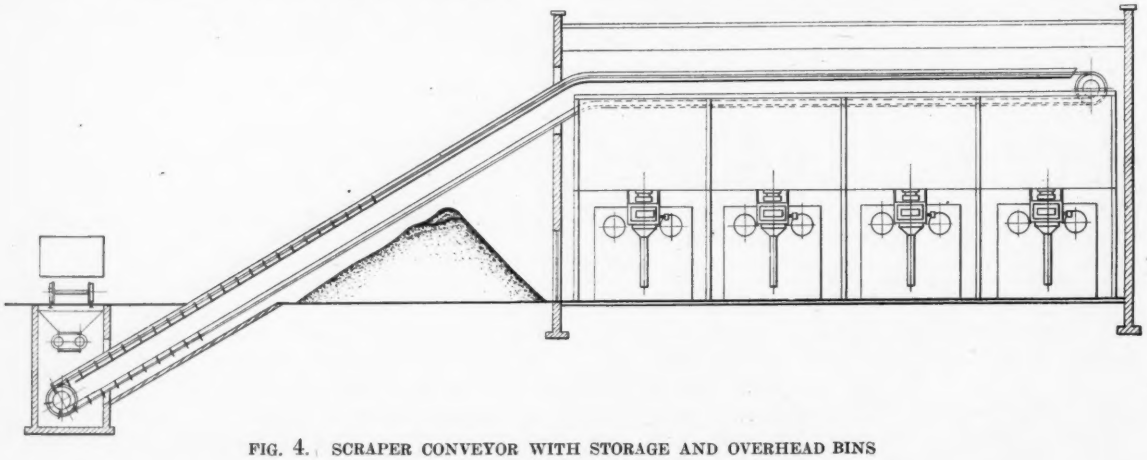


FIG. 4. SCRAPER CONVEYOR WITH STORAGE AND OVERHEAD BINS

### Scraper Conveyor Layout

In Fig. 4 is shown a scraper conveyor layout. This form of conveyor requires considerable space for the elevating flight, and the power necessary to drive it is greater than in other types; but it has large capacity and allows of some storage under the inclined flight as indicated in the figure. This storage is an emergency proposition and must be reclaimed by wheelbarrow and returned to the conveyor at the ground level, or wheeled

to the boilers. The first cost is low, but repairs and maintenance are likely to be high. Coal is dumped from the cars into a concrete hopper as shown, in which a crusher, if used, may be installed. The layout shows an automatic scale to each boiler, which, while expensive, gives an absolute check on the coal burned. The drive should be installed at one end of the bunker, preferably the end farthest from the track hopper.

### The Skip Hoist

An effective means of handling both coal and ashes, which does not seem to have been accorded the recognition it deserves, is the skip bucket. When electrically driven, with automatic control and limit switches, it is almost fool proof, and will very nearly operate itself. Figure 5 shows a skip bucket applied to coal handling. The coal is dumped from the cars into a track hopper and delivered to the skip bucket, which elevates it to an overhead bin, or a conveyor. It might also be used in connection with the layout shown in Fig. 2. Figure 6 shows the skip applied to an ash handling system. The ashes are wheeled from the plant in cars and dumped either into a small hopper, or into the skip itself and then elevated into the large overhead storage hopper. The latter delivers to railroad cars, or wagons. Modifications of the above schemes to fit local conditions will

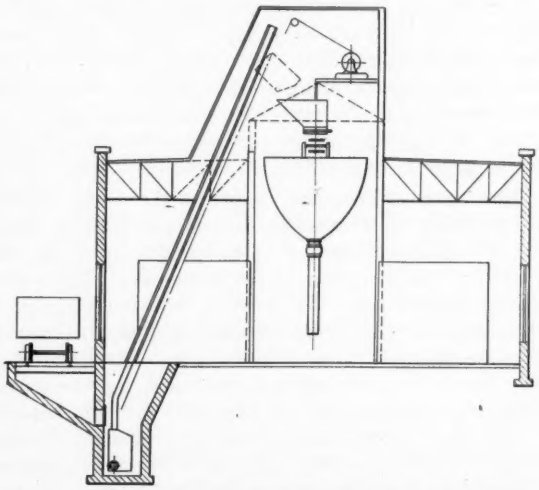


FIG. 5. ARRANGEMENT OF SKIP HOIST FOR COAL HANDLING

be obvious. The skip bucket is cheap in first cost, requires little maintenance and practically no labor to operate. When the bucket is loaded, a switch is thrown in, the bucket is hoisted, dumped, lowered to its original position and the current cut off, all automatically by the controller, so that the only operating attention necessary is the closing of the switch.

All, except one, of the above schemes have a weakness which is common to most coal handling systems, namely, that they require the coal to be delivered in hopper bottom cars for rapid and economical handling. By proper instructions and insistence, with the coal companies and railroads, hopper bottom cars can be obtained. If a few gondolas come in, they must be unloaded by hand, which is a slow and expensive process. The scheme shown in Fig. 3 has the advantage of handling gondola cars nearly as well as the hopper bottom type.

Proper means of weighing and recording the coal fed to the boilers should always be installed if possible. Such records are indispensable to any attempt at plant economy. Automatic scales, when properly maintained, are a good investment. They should be looked after and checked at frequent intervals.

### Crushers

Where coal crushers are installed they should be of rugged design and heavy construction. Crushers are a very poor place to save money in initial cost, at the expense of strength or capacity. Buy them of ample capacity and install a spare crusher. Remember that they are at times called upon to handle coupling pins, journal

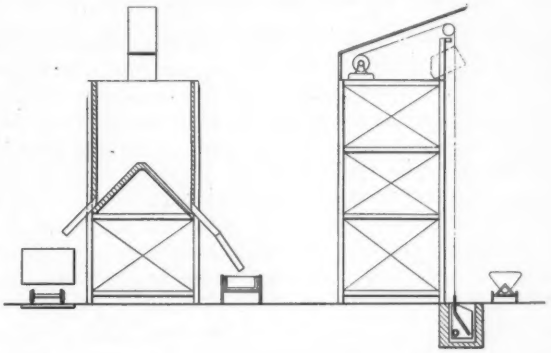


FIG. 6. SKIP BUCKET APPLIED FOR ASH HANDLING

boxes and other things besides coal. They should be of a type which will allow such articles to pass through without injury. Some of the "coffee-mills" which are placed on the market to crush coal are positively ridiculous.

Any valves used in the coal handling system should be of the duplex, or some swinging cutoff type, with the operating handle in a handy position. Make them of cast iron, large enough and heavy. It is a common fault to install valves which are too small.

It will be noted that not much has been said on the question of storage in the foregoing. It is usually too expensive a proposition to be considered by small plants to any extent. All of the schemes outlined give moderate storage capacity, and in the case of Fig. 3, a considerable amount may be obtained at small expense. In studying any plant situation it will soon become apparent that it is a simple matter to put coal into storage, but that it is difficult to reclaim it efficiently without making a considerable investment.

In laying out the coal handling system, particular attention should be given to the plant surroundings and topography, as it is often possible to take advantage of local conditions to reduce initial cost, or operating expense. The writer distinctly remembers one case that was turned over to him, after bids had been received on several elaborate and expensive systems for handling small anthracite coal. The quotations were so high that it was out of the question to consider the expenditure, but at the same time it was necessary to install some system as the plant had outgrown the wheelbarrow scheme. A visit to the plant to study the conditions first hand,

soon developed the answer. The main line of the railroad over which the coal was received ran along the side of a steep hill, past the plant. The elevation of the tracks was about 6 ft. above the top of a coal bunker which was part of the proposed change. A spur was built from the railroad over the coal bunker and the coal dumped from the cars directly into the bunker. This scheme was simple, cheap, of large capacity, and required little maintenance and labor to operate.

Careful study will usually solve the question properly, and in making this study first cost, maintenance and operating expenses should be kept in mind. Quotations and suggestions from manufacturers should always receive consideration; but the final decision should be based upon these as modified by a thorough knowledge of the plant conditions, and an application of what one engineer has aptly termed "the coefficient of common-sense."

# The Use of Powdered Coal*

RECENT DEVELOPMENTS PROVE PRACTICABILITY OF THIS FUEL PARTICULARLY FOR SOME SPECIAL SERVICES SUCH AS LOCOMOTIVES AND METALLURGICAL FURNACES. BY JOSEPH HARRINGTON

POWDERED coal has been under consideration as a fuel for over 20 yr., and its apparent advantages have attracted the attention of engineers ever since the early experiments which were naturally crude, and failed largely because of the lack of proper machinery for reducing the coal to the required state of fineness. It wasn't fully appreciated that the coal had to burn while floating in the air in the form of dust.

Sufficient experimentation was carried on, however, to prove that powdered coal would burn under these general conditions, and would develop a particularly intense flame. In fact, one of the chief difficulties encountered was the melting down of the furnace due to the blast-like effect of the jet of coal and air.

After the early failures there was very little done to develop further this resource for a number of years, but about 5 yr. ago the matter was revived, and with the development of adequate pulverizing machinery, extensive and practical applications have been made.

The first general field of usefulness to which it was applied, was to the burning or clinkering of cement. The coal was not required to be pulverized particularly fine. The velocity of the jet of coal and air entering the kiln could be high and little or no difficulty was encountered from deposits of slag or ash. The next general application of this fuel was in the simpler metallurgical processes in the heating furnace, where excessive temperatures were not required and where the ash deposits were either continuously removed with the material to be heated, or could readily settle on the hearth and be later withdrawn.

In 1912 the American Iron & Steel Manufacturing Co. had carried their experimentations to a point where they were ready to publish statements of the successful use of the fuel. At the Lebanon plant they have used it in puddling and heating surfaces, and small reheating furnaces for nut, bolt and spike bars, and in larger furnaces for continuous billet heating, and open hearth melting.

## REQUIREMENTS OF PULVERIZATION

THE CONDITION in which this fuel must be to produce satisfactory results has been developed to a point where it can be considered as definitely standardized. Not only for the sake of combustion efficiency, but for the sake of more perfect pulverization, the coal should be practically dry, 1 per cent of moisture being the maximum amount at which pulverizing can properly be effected. One-half of 1 per cent of moisture is the figure which is ordinarily required. Under these conditions the coal when pulverized remains quite fluid, and will break down under the influence of the crushing rolls with much less expenditure of power than when damp.

In order that the fuel may remain suspended in the carrying air, and in the furnace chamber during combustion, it is necessary to reduce it to a certain degree of fineness. After a great deal of experience this standard has been established as follows: 85 per cent must pass through a 200 mesh screen, and 95 per cent must pass through a 100 mesh screen. When these requirements are fulfilled there is an indeterminate amount of impalpable product of which the absolute size is beyond our ability to measure.

Much has been printed regarding the quality of coal most suitable for pulverization, but no arbitrary limits can be established as to the proximate analysis most suitable. Broadly speaking, the greater the volatile combustible content the more readily will the coal ignite, and burn, and the less dependent will be this process upon the size and proportions of the combustion chamber. As the volatile content decreases, however, more dependence must be placed upon the proportions and location of the surrounding brick work in order to maintain the temperature until ignition is complete. Anthracite coal has been burned in a pulverized form, but it must be very finely ground and must be burned in a rather confined space so that the ignition may be prompt and aid rendered by nearby brickwork during the period of early combustion.

## PULVERIZING MACHINERY

SEVERAL TYPES of machinery which are commercially marketed will satisfactorily pulverize coal. They are divided broadly into air separation machines and screen machines. In the former class there is an upward current of air produced by a fan which has a carrying capacity sufficient to take with it the finest particles, but which will not lift the coarser ones. As soon, therefore, as the coal is reduced to the required degree of fineness this air current will lift the particles and take them away and will then deposit them in a receiving tank by means of a cyclone separator, which is usually vented in some manner to prevent the loss of dust.

*From a paper read before the Chicago Section of the A. S. M. E., May 15, 1916.

In the screen mill the coal is continuously thrown against a screen which permits the fine particles to pass through, but causes the coarser particles to fall back under the rolls. Pulverization can be effected in a tube or ball mill with an expenditure of power and cost not greatly different from that of the other types.

### The Burner

Pulverized fuel being collected in a hopper is conveyed either by screws or pneumatic means to the burner, which is situated at the furnace to be served. At this particular point we find a great divergence of opinion and a greater variety of apparatus than at any other point of the entire system. It is now generally conceded that the most efficient results are obtained when the coal dust is carried into the furnace in a stream of air, the volume of which is just sufficient to supply the oxygen necessary for its complete combustion.

This mixture of coal and air must be made in fairly close proximity to the furnace. The reasons therefor are that when this mixing is done there is produced an explosive compound which it is not desired should be of any greater extent than necessary. The velocity of the entering jet must be greater than the rate of flame propagation to prevent burning back into the pipe.

The other reason for making the explosive mixture close to the furnace is that there is a tendency for the coal to separate and lose its uniformity of mixture under which condition it is obvious that part of the jet would be oversupplied with coal and the other part oversupplied with air.

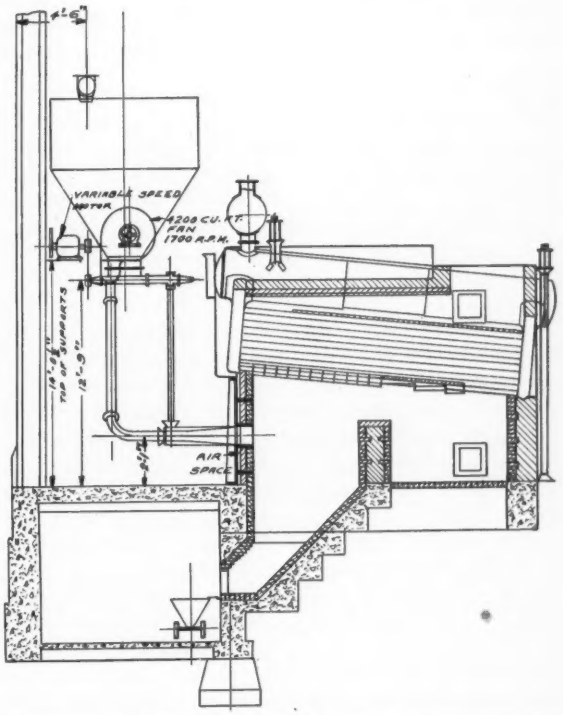
In one of the existing commercial installations the fuel is removed from the storage hopper by means of a screw of special design. This screw is placed at the bottom of the hopper and is usually driven by some form of variable speed device, thereby securing control over the amount of coal extracted per unit of time. It is a well-known fact that the delivery from such a screw is not uniform, the coal being delivered in little bunches and producing a distinct pulsation in the furnace. To reduce this effect these screws have been made of double and triple thread, in which case 2 or 3 discharges per revolution are produced in place of one. This is a distinct improvement, of course, but even under these conditions a very noticeable pulsating effect is observed.

Devices have been developed for passing this discharged material over a perforated screen or over a moving disk operated at a considerable speed, the idea being to smooth out the inequalities and produce a continuous flow of dust. Some of these devices have proven their ability to secure this effect, which is all important on account of its direct influence on the character of the flame in the furnace. Once established this uniformity must be maintained and if it is necessary to have the mixer at any considerable distance from the furnace, means must be provided for continual agitation of the air current in order that the fuel cloud may remain of constant density. This is not a very difficult matter, but is one which must not be overlooked.

### Objections and Difficulties

Early experimenters did not understand the necessity of fine grinding, and it would seem that they did not appreciate the influence of furnace design upon the temperature of the resulting gases. The coal was powdered sufficiently fine, however, to develop intense temperatures, even though part of the coal was lost by falling to the bottom of the furnace and being extracted with the slag and ash.

Insufficient combustion space and the ease with which this fuel can be mixed with the minimum amount of air combined to produce abnormal temperatures and a direct contact of flame and brick work. The blow pipe effect of the high velocity jet acted to melt out the brick work upon which it impinged. A layer of melted lava formed by the fusing of both ash and brick work, formed in the bottom of the combustion chamber, and naturally discouraged the people who depended upon this fuel for continuous service.




LONGITUDINAL CROSS-SECTION OF FURNACE AND BOILER USING POWDERED COAL

Later on difficulty was encountered due to the minute particles of liquid slag being carried on in suspension and deposited upon the tube sheet or water tubes of the boiler, thereby closing up the flame space and putting the boiler out of action. These effects are particularly noticeable with certain grades of coal, but noticeably absent with other grades of coal. Only until recently has the research work been carried to a point where any knowledge has been obtained of what causes this trouble, and what coals are most suitable for this work.

### Advantages

From the viewpoint of the theorist, powdered coal forms one of the prettiest propositions ever advanced for the promotion of combustion efficiency and commercial economies. There is in all transformations of energy unavoidable loss, and we are not possessed of apparatus

which will gasify coal with 100 per cent efficiency. In the producer there is a string of losses which reduce the available heat in the gas to a considerable extent, and in the mechanical stoker there are unavoidable losses due to various forms of incomplete combustion. Only in the case of powdered coal is the actual solid fuel both gasified and completely consumed directly within the chamber desired to be heated. With perfect pulverization the entire mass is burned in suspension, and in actual practice but a small fraction of 1 per cent is actually lost in the flue dust or slag pan.

On account of the fuel being conveyed into the furnace by the very air which is afterwards to be used in its combustion, and on account of the diffusing of the coal throughout the air in cloud-like formation, there is a possibility of a mixture which can be secured by no other means. Each particle of coal is surrounded by a particle of air, and on account of the extreme fineness of the particle practically instantaneous oxidation occurs.

The result is efficient combustion and we have to deal only with the effects of the high temperature thereby obtained. That it is now possible to control this temperature while not sacrificing any material gain due to it, is definitely established. Moreover, the definite control of the amount of air per unit of coal permits of the most perfect variation in the results obtained.

### Stationary Practice

It must be confessed, I think, that steam generation by the use of powdered coal as a fuel is still in the experimental stage, and herein, if anywhere, powdered coal will meet severe competition. With the exception of the M. K. & T. installation at Parsons, Kansas, which is now being put in by the Fuller Engineering Co., all of the steam making installations are in the plants of the manufacturers of powdered coal equipment, or in plants directly connected therewith. That steam can be efficiently produced in this way is unquestioned if the mere matter of combustion and evaporation is considered. Whether it can be done more economically than is at present done by the best mechanical stokers, still remains to be commercially proven, and even with powdered coal, gas analyses better than 16 per cent of $CO_2$ are not developed. With the mechanical stoker the $CO_2$ can be maintained around 14 per cent.

With powdered coal the loss in the ash pit and in the flue does not exceed 1 per cent, and in the best mechanical stokers will not exceed 2 per cent of the coal fired. A possible advantage in favor of powdered coal of 2 or 3 per cent in combustion efficiency is offset by the cost of fuel preparation. It is not reasonably to be anticipated that we can get better than 96 per cent efficiency and this is a figure which can be obtained by the mechanical stoker. I foresee, therefore, a hard fight for powdered coal in stationary steam boiler practice.

### Ash Fusibility

A phase of the combustion problem, both in connection with powdered coal and mechanical stokers, which is but now receiving adequate attention, is the study of the temperatures and conditions under which ash will melt. Engineers have always recognized the fact that certain coals were greater clinker producers than others, and this was laid at the door of the sulphur content. Recent experimentations, however, have shown that the sulphur is not the controlling element, although the exact causes are not yet sufficiently well known to be definitely stated.

Coal ash will melt at temperatures between 2200 deg. and 2700 deg. Furnace temperatures in commercial practice run between 1800 deg. and 2800 deg., so that it is possible to secure coals, the ash from which will pass through the furnace without fusing. Under these conditions absolutely no clinker formation is encountered, and the coal is rated as satisfactory from this standpoint.

In exactly the same furnace another coal will clinker badly and give trouble. There is no hard and fast rule, therefore, which can be stated for the selection of a coal.

The Commercial Testing & Engineering Co. has determined that washing a dirty coal made no difference in the fusing point of the ash, so that mere ash content is not the determining factor of desirability when considering a coal for pulverization. The importance of this preliminary investigation can scarcely be overstated.

The temperature obtained in service, which is a function of the rate of combustion, the amount of excess air and the proportions of the furnace chamber must be determined, and analyses of fuel made to determine whether or not it will be suitable under the given conditions. Like many other scientific investigations the value of a few dollars spent in this manner is not always appreciated, and the user will tolerate the formation of clinkers for months before he turns to another source of coal supply. When he does so, he may or may not solve his problem, and it becomes necessary to purchase and consume a variety of coals before one is found which is suitable to his needs.

In powdered coal work with the more precise and scientific manner of the combustion process, the necessity for proper knowledge of the point of ash fusibility is greatly increased. The day is rapidly approaching when the burning of coal will be considered a precise scientific chemical reaction, in which the elements are supplied with exactness and understanding, and the result obtained corresponding in definiteness to the precision of the mixing process, will be made to conform exactly to the requirements of the service.

### Conclusion

Powdered coal is radically different in its physical structure and method of handling from any other form of coal heretofore commercially used. Having marked characteristics it will fit into certain cases with extreme acceptability, and will probably prove just as undesirable in certain other cases. Probably the most important difference is the burning of the actual solid fuel directly within the chamber, and in direct physical contact with the metal to be heated. There is, of course, an appreciable amount of incandescent carbon in the furnace at all times, and this solid fuel is emitting radiant heat in close proximity to the furnace contents. A large amount of the radiant energy is, therefore, directly utilized, which is not the case with the gasification of coal in a detached chamber. I cannot but conclude, therefore, that the success of powdered coal lies in its

adaptability to the special furnaces of the metallurgical field, and in those cases similar to the locomotive where there are other and weighty considerations in addition to the actual relative increase in combustion efficiency.

### Discussion

During the discussion which followed the presentation of Mr. Harrington's paper it was stated that the M. K. & T. plant at Parsons, Kan., is just being put into operation. It consists of 10 Heine boilers of 250 hp. rating with space provided for 2 more. The furnaces are lined with firebrick and the lower baffle is also of firebrick extending beyond the bridgewall, as indicated in the illustration. The bridgewall is 7 ft. from the burners and an area of 19 sq. ft. is provided between the bridgewall and the baffle which gives a normal speed of 15 ft. per second to the gases.

In locomotive practice it is customary to inject 20 per cent of the air required for combustion with the fuel through the burner, the remaining 80 per cent is brought into the furnace by induction.

It was also stated that experiments have been conducted which show that slag is caused by the iron in the coal. When insufficient oxygen is supplied ferrous oxide (FeO) is formed and slag results, but with a sufficient supply of oxygen the iron combines to form ferric oxide ($Fe_2O_3$) and no slag is formed.

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# Clean Blades for Turbines

Causes of Scale in Low and Mixed Pressure Turbines and How It Can be Removed. By W. E. Smith

BLADING of low and mixed pressure turbines sometimes becomes partly filled with a gummy deposit formed by the oil used in the high-pressure units, combined with carbonates or sulphates carried over from the boilers with the steam. This lessens the efficiency of the turbine in proportion to the amount of deposit allowed to accumulate on the blades. When a turbine begins to lag and take more steam to carry a given load, it is often due to this cause.

After the scale is once formed, the only way to remove it is to scrape each blade to loosen the scale, then take a blow torch filled with kerosene or carbon oil and using it as a sprayer, go over the blading thoroughly to dissolve what may remain. After applying the oil, wait a few minutes and blow it out with a steam jet. Repeat this treatment a couple of times and the blading will be perfectly clean.

The blading can be kept clean while the turbine is in operation by the use of kerosene in the following manner. Nearly all low and mixed pressure turbines have a gage piped to the low-pressure inlet to show the pressure or vacuum, as the case may be, owing to the load and amount of steam. A branch with a valve may be placed on this pipe and, at a time when there is vacuum at the inlet with some steam flowing, the oil may be drawn into the turbine, where it is mixed with the steam. This plan should not be followed unless the conditions are right at certain intervals, such as at noon and midnight; for to secure the best results, the oil must be used regularly.

If the oil cannot be drawn into the inlet in this way, a tank may be set high enough to overcome the inlet pressure and the oil injected in that way.

Use 1 gal. of oil twice a day per 100 kw. capacity of the turbine, and have the pipe large enough to pass that amount in 30 sec. or less.

The saving in steam used will pay for the oil many times over, and anyone who has scraped the dirt out of a low-pressure turbine knows that it is a job to be avoided if possible.

If fibrous packing is used on the joints of the steam line, some of it may pass into the turbine with the steam and collect on the first rows of stationary blading, where it obstructs the passage of the steam through the machine.

The effect of this condition is failure of the turbine to carry its load when the supply of steam at the inlet is sufficient, owing to the fact that the steam that passes the obstruction is expanded before it passes through all the rest of the blading.

If the steam is expanded to a pressure corresponding to the vacuum before it passes the last rows of blading, it can do no work on them, and, in fact, will cause a loss, as it takes power to move the idle blades through the expanded steam.

This condition would not be possible in a turbine carrying its rated load, for it would have to be cleaned long before it reached this stage; however, it can be easily understood that if the steam is obstructed in its passage through the so-called high-pressure stage of a low-pressure turbine, the intermediate and low-pressure stages will not get enough volume of steam to work up to their capacity.

Since, in installations of this kind, the steam not used in the turbine is usually wasted, it is the best policy to keep the plant at the highest point of efficiency that can be maintained under conditions as they may exist in each case.

This requires that the blading must be kept clean and free from scale at all times, and that at certain intervals there must be a thorough inspection of the turbine to make sure that it is in good condition.

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To make available to business men generally, a means of training men for export work, courses in Foreign Trade have been organized, Dr. Edward E. Pratt, Chief of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce, as director, associated with a group of men prominent in American export activities, including O. P. Austin, of the National City Bank, New York; E. N. Vose, Editor of Dun's International Review; E. A. De Lima, President of the Battery Park National Bank, New York; Prof. E. R. Johnson and Dr. G. G. Huebner, of the University of Pennsylvania.

In Dr. Pratt's opinion, the chief problem in foreign trade expansion today is to meet the demand for men trained to handle this business, and the course is designed to aid manufacturers, banks, export houses and other concerns in giving to men in their organization adequate training for this work. The course is being issued through the Business Training Corporation, 185 Madison Ave., New York.

# Electrical Machinery and Appliances

*For Generating, Transmitting and Using Current*

## Commutator Troubles

EFFECT OF ABRASIVE BRUSHES AND HARD MICA. WHAT COMMUTATOR APPEARANCE SHOWS. BY A. W. ARCUTT

IT does not take an engineer to know that something is radically wrong when a motor or a generator begins to spark badly and flash over, but it sometimes requires an expert to tell what is causing the trouble and how to remedy it. On the other hand, a machine may be running fairly smoothly, with little or no sparking and yet be giving exceedingly unsatisfactory service from the standpoint of commutation. The appearance of commutators may be classed under one of the following heads: Raw, copper color, bright, glossy finish; chocolate-brown gloss; dark-brown or black appearance.

A raw, coppery-looking commutator always denotes bad operation and indicates that too abrasive a brush is being used, which is grinding the commutator down rapidly. If allowed to continue, the bars will have to be replaced in a comparatively short time. If the commutator is slotted, the slots gradually fill up with copper dust, causing short-circuits which may burn out the windings. The remedy is obvious—use a brush containing less abrasive material.

Cases are often encountered, principally in the older machines, where the insulating mica between the commutator segments is very hard—harder, in fact, than the copper segments themselves. The copper therefore, tends to wear away faster than the mica, and as this is a commutative action, after a while the mica will project noticeably above the commutator surface and the brushes will make poor contact or sometimes no contact at all, causing poor commutation and disastrous sparking. As a remedy, commutator slotting has proved highly successful in many cases, but its value in some cases is questionable, and there are instances when it appears to be objectionable. In order to keep this high mica flush with the face of the commutator a brush must be used that will cut it away as fast as the commutator wears; these brushes are known as "abrasive."

The terms "hard" and "abrasive" must not be confused. The bottom of a glass inkwell is hard, yet it will not scratch a desk, while a much softer piece of sandstone will take off all the varnish, because of its abrasiveness. Hard brushes are always desirable, since they wear much longer, but abrasive brushes wear both themselves and the commutator rapidly; hence, where they are necessary, the minimum abrasiveness required should be sought.

Theoretically, a brush can be made just abrasive enough to keep hard mica down without cutting the copper perceptibly. This would give the commutator a rather brown, glossy appearance. In practice, however, it is difficult to obtain a brush of the exact composition required for any particular machine, and one of a little higher abrasiveness is generally used. The commutator will then remain bright, but will take on a high polish. It will be evident that this is a compromise, but the operation is satisfactory, though the commutator will wear perceptibly in time.

Many operating engineers and electricians believe this bright, glossy surface denotes the ideal operating condition. As a matter of fact, except in the case cited, where there is high mica to contend with, brightness usually indicates unnecessary wear of both commutator and brush.

Suppose we disassemble a direct-current motor or generator, remove the armature and set it up in bearings, then revolve it under a hard non-abrasive brush. The commutator will soon take on a bright gloss if the operation is perfect. Now, if current be passed through the brush into the commutator, its color will darken considerably. To this extent, then, the advocates of bright commutators are correct—perfect operation of the brush against copper will produce a bright, glossy surface, but only when no current is flowing. On machines in service the same perfect operation will give a chocolate-brown gloss. The chocolate color is no doubt produced by some carbon deposits on the commutator, but the quantity is so minute that the thickness of the film cannot be measured; it is probably an alloy of copper and carbon. After the glossy film has once formed there is no further deposit or alloying, so that the film becomes no heavier; hence there is no tendency to fill up the slots of slotted commutators or to cause flashovers if unslotted.

The chief advantage of operating so as to keep the commutator in such a condition is that it indicates the minimum possible wear of both commutator and brush. A lesser advantage is the fact that, being darker, it radiates heat faster than a bright surface and thus keeps the commutator cooler.

If too soft a brush is used the commutator will become darker and darker, taking on a gummy appearance caused by heavy deposits of carbon or graphite from brushes. This condition is especially to be guarded against. From the operating standpoint it is bad, because it fouls the commutator, fills up the slots (if the commutator has been slotted), or bridges across the

mica, causing flash-over, heavy sparking and short-circuits. From the brush standpoint it is almost equally bad, since the brushes will wear rapidly. The obvious remedy is to sandpaper the commutator, clean out the slots and use a harder brush.

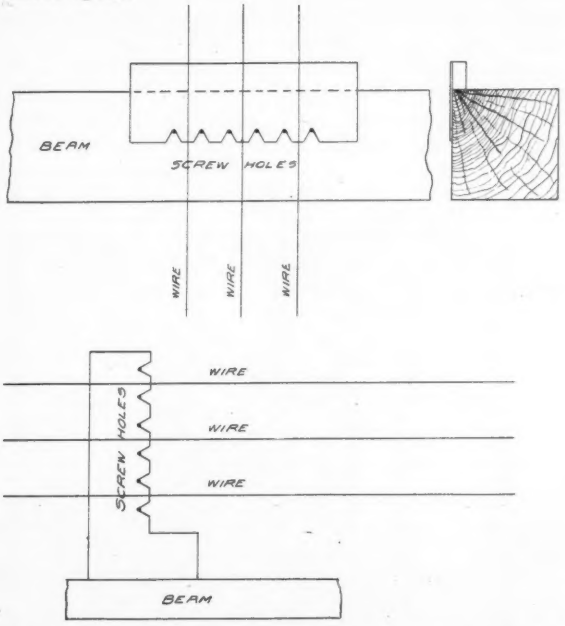
Operating experience as well as theory both indicate that best commutation and longest brush life occur when commutators are kept on the middle ground between a bright, glossy surface and one which is dull black; that is, a glossy chocolate-brown.

## Cleat Lining Device

By T. H. Reardon

IN running wires for power circuits in doors, wires are largely supported by single wire cleats, the cleats, when running wires parallel with beams, being supported by the ceiling and when run at right angles to beams being attached directly to the beams.

When the cleats are attached to the beams they should be placed on a straight line coinciding with the middle of the beam and with cleat centers equal distances apart.




CLEAT LINERS FOR WIRES AT RIGHT ANGLES AND PARALLEL TO BEAMS

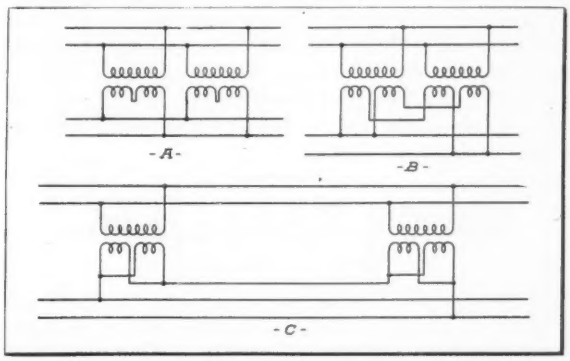
As work of this kind is frequently done in very dimly lighted places the writer has made use of a cleat liner easily made in a few minutes, which, when adapted to a particular width of beam and the proper space distance between screws, gives perfect alinement, and the location of 6 screw holes all in one operation. To make for wires at right angles to the beams, take a piece of ½-in. pine board, nail another piece of straight edge ½-in. board ½ in. wide, on top of it flush with one edge; draw a straight line parallel with this strip at a distance equal to one-half the width of the beam and lay out the screw hole marks on this line that will give the cleats the proper spacing. The board should be of such width that the V-shaped notches will be about ¾ in. in depth, the notches cut at an angle of about 45 deg. with the bottom of the V on the line representing the center of the beam.

For cleats running between beams and parallel therewith on the ceiling the device shown below is used being in the form of a square which gives the distance between the beam and the different wires or cleat centers and also insures that the wires are at right angles to the beams. The longer arm of this square can conveniently be of such length that it will serve as a spacer to separate the different sets of cleats the proper distance from each other, for example, 4 ft. apart.

In driving holes for cleat screws great pains should be taken to have the holes either bored or punched as nearly vertical as possible.

## Transformers in Parallel

FOR single-phase transformers to operate satisfactorily in parallel it is necessary that they have the same ratio and same regulation at all power-factors. Unless the regulation of the 2 transformers is the same, if the voltages are equal at no load they will be unequal at full load, and the transformer with the higher voltage will carry more than its share of the load. It is desirable to use transformers of the same size for parallel operation; but if they are not of the same size they can be paralleled if their regulation is the same, i.e., if the terminal voltages of both transformers at ¼, ½, full



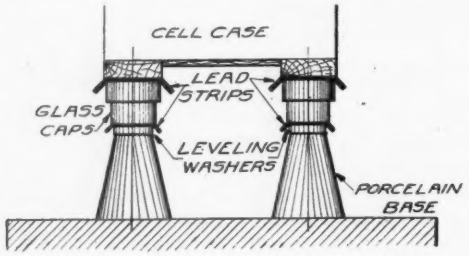

DIAGRAMS OF TRANSFORMER CONNECTIONS FOR PARALLEL OPERATION

load, etc., are equal. With parallel transformers, just as with any parallel circuits, the terminal voltages are necessarily equal. If the voltage of both transformers is the same when each is carrying an equal part of its rating, they will divide the load properly regardless of their relative ratings. If the terminal voltage of one transformer at ½ load is higher than that of the other at half its rated load, the first transformer will take more than its share of load just as an over-excited shunt generator in parallel with another will take more than its share.

If 2 transformers of the same size, connected as in A of the accompanying figure, do not share the load properly, they may be made to divide the load and operate satisfactorily by reconnecting as in B; or if the transformers are separated by any considerable distance, the secondary sections of each transformer may be connected in parallel and the 2 transformers in series as shown in C.—The Electric Journal.

# Supports for Storage Battery Cells

THE accompanying illustration shows the method employed by the New York Edison Co. for supporting standby battery cells. To the bottom of each cell case, along the longer sides, are attached 6-in. wood strips which transfer the weight of the cell to the supports. The latter consist of conical-shaped porcelain bases with glass caps containing oil rings. Between the bases and caps and also between the caps and cell cases




PORCELAIN BASES WITH GLASS CAPS USED TO SUPPORT BATTERY CELLS

crossed strips of lead are placed which serve to distribute the pressure uniformly over the surface of the glass and porcelain. These strips are also employed to make each support take its share of the load and to level the cell cases. With 123-plate cells rated at 9150 amp. on the 1-hr. discharge rate 6 insulating supports are employed.—Electrical World.

# How the Flywheel Helped

By E. C. Parham

NEARLY all electric motors are able to stand momentary heavy overloads without injury, provided such overloads do not occur too frequently. Overload capacity is necessary because many connected loads are such that more energy is required to start them than is required to keep them in motion. Where the connected load has a great amount of inertia, overload starting conditions are apt to be prolonged; therefore, in some cases, it is necessary to arrange for throwing the connected load on with some form of clutch after the motor is up to speed. On the other hand, it is often necessary to introduce inertia in the form of a flywheel, which requires time for getting up to speed, but which stores energy by virtue of its mass and motion and returns this stored energy to the system when needed.

A hops shipper had for a long time used a 5-hp. gasoline-engine-driven press for pressing the hops into shape for shipment. The engine had a flywheel the inertia of which would carry the engine over the load peaks corresponding to the ends of the strokes of the press ram. As the load was clutch connected to the engine, the engine was not subjected to the peaks except when up to speed. The gas engine had given considerable trouble, which the operator had tolerated for some time. With the advent of electric service, however, he decided to use a motor, and as the gas engine was of only 5 hp., he bought a motor of like rating.

The motor would, however, not do the work because, as the peak loads came on, it would blow the heaviest fuses that could be inserted into the fuse holders. Although Mr. Hops Shipper was now in trouble, he knew how to get out of it. He applied that old gas engine flywheel to the motor to carry the peaks, which it did without any sign of distress.

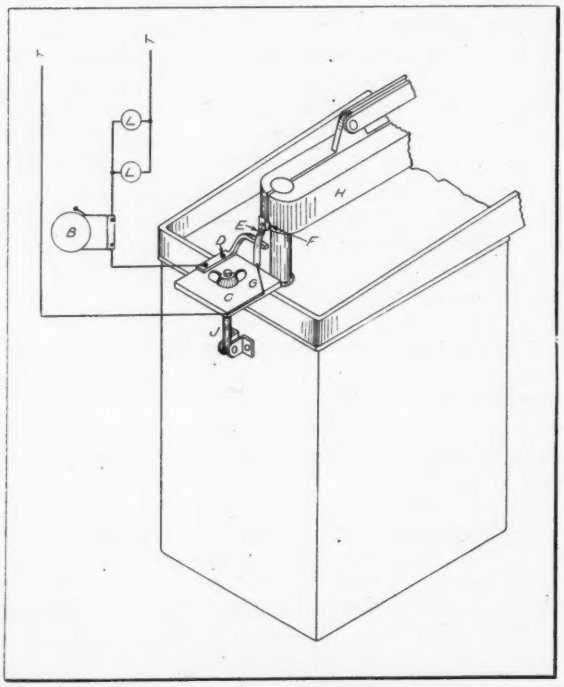
# Alarm for Circuit Breakers

By R. L. Mossman

ACCOMPANYING is a sketch showing an alarm bell attachment for circuit breakers, which was made by the writer and applied to oil circuit breakers of the G. E. type.

This attachment consists of a piece of fiber, C, about 2½ in. square, by ½ in. thick, and having a hole bored in the center large enough to receive the holding bolt, J.

Contact pins, D and E, are made of spring brass, E having a fiber block, F, fastened to its upper end and




ALARM BELL FOR CIRCUIT BREAKERS

held in contact with arm H when the breaker is closed and the arm is in the upper position, as shown, preventing E from making contact with D. When the breaker opens, the arm, H, drops below the block, F, allowing E to make contact with D, closing the circuit and ringing the bell, B.

Current for the bell circuit was obtained from the exciter bus bars by means of 2 32-c.p. lamps shown at L, L, one terminal being connected to D and the other terminal to E by a wire, G.

If desired, current from batteries may be used instead.

# Unique Hydraulic Power Plant*

USE OF THE DISCHARGE ACCELERATOR WITH HYDRAULIC TURBINES. BY MARK A. REPLOGLE

AT the Henry Ford Farms, Dearborn, Mich., the hydraulic power plant contains 2 turbines designed to develop 85 hp. each at 110 r.p.m., under 8-ft. head, together with electric generators. The plant supplies current for light, heat and power for Mr. Ford's residence, for the village pumping station, and for the miscellaneous requirements of the farms. It was built to operate under somewhat unusual conditions of head.

The plant is located on the river Rouge, near its junction with the Detroit River, which latter varies considerably with the levels of the Great Lakes. The Rouge River is subject to the widest extremes in flow. At the point of location of the plant is a dam over which the normal run-off is 100 sec.-ft. There are short intervals, however, when the run-off is so great that it fills the valley with water so that no sign of the dam is apparent; at these times the head over the dam is completely destroyed, but the condition lasts only a few hours until the high water wave has passed. There are longer periods when the level is affected by the Great Lake conditions causing back water in the tail race and consequent lowering of the head for days at a time. Also, there may be weeks of surplus flow at semi-high head. In fact, the conditions may be summarized as

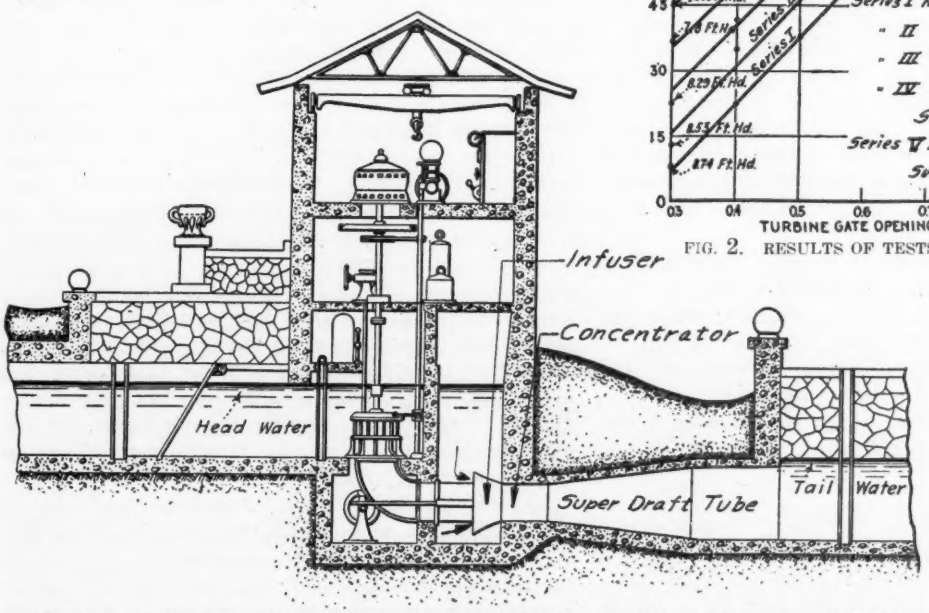



FIG. 1. CROSS SECTION OF POWER HOUSE SHOWING RELATIVE LOCATIONS OF TURBINE AND DISCHARGE ACCELERATOR

*a.* Low water with normal head.
*b.* Low water with head lowered by Great Lake conditions.
*c.* Normal flow under variable heads.
*d.* High water with approximately half normal head, which is also variable and dependent upon Great Lake conditions.
*e.* Very high water, but with head almost destroyed.

*Abstract of paper read before the A. S. M. E.

## THE POWER PLANT

ORDINARY PRECAUTION led to the provision of 2 units, each having the capacity of the normal flow of the stream under 8-ft. head. The speed of 110 r.p.m. was established for full head conditions and this speed was maintained at all heads, varying from 1 ft. up to the full head

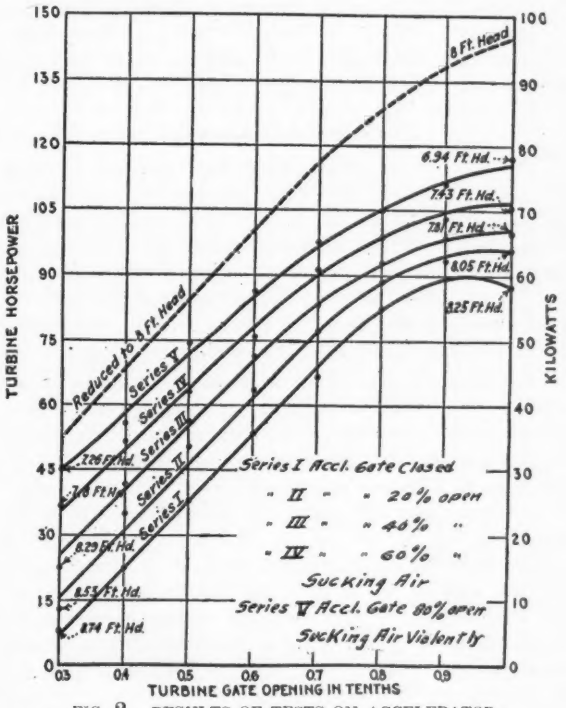



FIG. 2. RESULTS OF TESTS ON ACCELERATOR

of 8 ft. Herein lies the unique feature of this plant—the maintenance of full speeds and good power through a wide range of low heads and in the face of the condition that, under ordinary settings, the turbines employed require slightly over 4 ft. head to bring them to maximum speed at full gate and no load conditions.

The 2 turbo-generators are of the vertical type, 55 kw. each, at 250 v. They are direct current machines and have ample overload capacity. Each is self-con-

tained, having a roller bearing on top which supports all the rotating parts, including the balance wheels and turbines. A third steam engine generator is provided. This is horizontal, and is of 35-kw. capacity at 250 v. The governors are vertically driven, and direct connected. They are of the open system, oil-pressure type.

The 3 penstocks on the lowest floor can be closed by folding head gates, manipulated by the overhead crane. Of these penstocks, the middle one is a common feeder for the others, each of which contains what has been termed a "turbine discharge accelerator." These accelerators are a form of draft tube, into which each turbine discharges and into which, also, water from the head race is discharged through a feeder. The head race water accentuates the turbine flow through the draft tube, having the same effect as an added head of head water.

### Discharge Accelerators

The purpose of the discharge accelerators is to transfer energy from surplus water (otherwise running over the dam or wasting) to the turbines, augmenting their power under subnormal heads after they have reached their otherwise full power at those heads. In other words, their effect is to boost the power of the turbines, working under low head conditions, beyond that which the conditions would seem to warrant.

The effect of the accelerator on the turbine is partially to remove the pressure at the discharge end without changing the pressure at the intake end. Under ordinary conditions, the pressure on both the head and tail water is 14.7 lb. per sq. in. alike. If the turbine were to discharge into tail water the pressure on which was, say, only 10 lb. per sq. in., the result would be the equivalent of adding slightly over 10 ft. head to the turbine, and as far as practical results were concerned, the turbine would now develop energy corresponding to the increased head. This is the effect of the discharge accelerator, which may therefore be likened in principle to a condenser of a steam engine.

Each accelerator consists of a super draft tube, a concentrator, and an infuser as shown in Fig. 1. The infuser is provided with a gate, by means of which the amount of accelerator water may be varied at will, or shut off entirely, in the latter case leaving only the turbine discharging into the super draft tube.

The area of cross section of the concentrator is less than that of the turbine draft tube.

### Accelerator Tests

A series of tests were made on the accelerator of one unit, and the results are plotted in Fig. 2. In this figure, the scale of turbine horsepower is given on the left, kilowatts on the right and turbine gate opening in tenths below. A normal speed of 110 r.p.m. was maintained throughout the tests.

The curve in Series V shows 116 turbine hp. at 6.94 ft. head. This curve, reduced by the well known formula, to an 8-ft. head shows that 143.5 hp. can be obtained by the use of the accelerator from an 8-ft. head in connection with the identical turbine that had been guaranteed to develop 85 hp. under 8-ft. head.

No attempt was made to measure the accelerator water used, as this test was made solely to demonstrate that a turbine can use waste water that would be detrimental to the power effects of the turbine if the accelerator were not used. The matter of measuring the water is a part of proposed further development, which will be continued until all the limitations are discovered.

The possibilities and limitations of the accelerator have not yet been fully determined, although several years of experimentation have been spent in its development. In its operation, there seems to be some new and definite law, which has not yet been formulated.

So far, indications are that low heads may be boosted as much as from 100 to 500 per cent, depending on the conditions. The extreme limit appears to be the atmospheric head.

There are many cases in which low heads only are available and the water cannot be utilized practically and profitably. The accelerator can be used to boost the head in such cases to an amount at which development of the water power is possible. The accelerator can convert an actual head of 3 to 10 ft. into a working or effective head of 8 to 20 ft.

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Commenting on the appropriations now under consideration by Congress for the promotion of American foreign commerce, R. Goodwyn Rhett, newly elected president of the Chamber of Commerce of the United States, has called attention to the necessity for the United States Government to take an advanced and liberal position in regard to the support of United States manufacturers in their effort to secure foreign trade, particularly if the smaller concerns are to participate with the larger in this business.

A recent referendum of the Chamber of Commerce showed that the business men of the country are behind the program for liberal expenditure for the Department of Commerce in its effort to assist in entering foreign markets. Tremendous effort is being made by Great Britain, and great preparations are being made by the central powers in Europe for fierce competition for business in foreign countries as soon as the European war ceases, and the difficulty of American firms in entering these markets will be greatly increased when these plans are put into effect. American business will have to make great effort to hold markets other than those in which it has become firmly established during the present conditions. Export trade has developed greatly, and foreign commerce has become an integral part of our national prosperity.

The House Committee on Appropriations, from its recommendations of funds for use of the Bureau of Foreign and Domestic Commerce, has not appreciated fully the necessity for immediate and large activity. Other governments are active in the matter of commercial treaties, diplomatic and consular representation, and protection of their interests abroad, and unless American firms are to be supported in like manner, they will be greatly handicapped, much to the disadvantage of our entire industry.

Mr. Rhett states emphatically that it will be false economy at the present time to cut down or refuse to grant appropriations looking toward the development of American commerce, agriculture and opportunities for labor.

# Brine Circulating System

COMPARISON OF ADVANTAGES OF BRINE AND DIRECT EXPANSION SYSTEMS; CARE AND ARRANGEMENT OF APPARATUS IN BRINE SYSTEMS. BY A. G. SOLOMON.

WHAT is known as the brine circulating system is used about as much as the direct expansion system in the cooling of produce in cold storage warehouses, packing houses and breweries. The brine is cooled to the desired temperature in brine tanks, brine coolers or double and triplepipe coolers. The most common form is the brine tank, which consists of a tank made of sheet steel and having ammonia evaporating coils in it, by means of which the heat is taken from the brine as it circulates around the pipes.

These tanks are insulated similarly to an ice tank in some cases, but sawdust or finely packed shavings are often used instead of cork board or granulated cork. In the south, where cotton gins are handy, a byproduct, known as cotton seed hulls, is used to good advantage. It is cheap and is a good nonconductor of heat. The top of the tank is usually made of insulated lids, which can be removed easily when necessary.

The ammonia coils are commonly made up of 1¼-in. pipe, but frequently 1 or 2-in. is used.

As in the ice tank, the top or the bottom ammonia feed is used, and either gives good results. In some brine tanks, the ammonia is fed into a manifold or header, from which all the coils get their supply; but in later years the coil arrangement is such that each coil has a separate expansion and suction valve. Better regulation is possible in this way, and each coil does its full duty of absorbing heat. Also in case of a leak the leaky coil can be shut off and all the others kept in operation.

### CIRCULAR TANKS

CIRCULAR tanks and coils are to be seen occasionally where the coils are arranged in nests, each nest having a separate expansion valve, and all the returns coming into one header. In this style, an agitator is usually provided which consists of a vertical shaft with propellers set at different heights. This agitator is operated by a belt drive or a motor set on top of the tank.

Most tanks have no agitators, but depend entirely for circulation on the incoming and outgoing brine. The cold brine is drawn from close to the bottom of the tank and the warm return brine from the coolers flows into the top. When the pump is handling full capacity, this means of circulation is sufficient; at such times as the pump is run very slowly, however, the agitation is slight, and parts of the tank will be doing little work, and if the brine is weak, ice will collect on some of the coils where the circulation is slow.

### CARE OF THE BRINE

BRINE must be kept strong enough so that it will not get thick and mushy when the lowest temperature required is reached. Test regularly with a salometer and add salt whenever it is needed. In what is known as the open brine system, moisture is taken up in the chill rooms or coolers, and if this amount is very much, the brine will consequently become weaker; some particles of salt are left on the curtains and pans in the rooms where the brine is circulated, and this will also weaken the solution.

For all ordinary purposes, the brine should show between 80 and 85 deg. on the salometer. At that strength, a temperature of 10 deg. above zero F. (—12.22 deg. C.) can be maintained without danger of ice forming on the coils. Greater strength than is necessary is not to be desired, as the specific heat decreases with the increasing density.

When lower temperatures are necessary, calcium should be used instead of salt.

The amount of ammonia pipe in brine tanks varies with the temperature that the plant is desired to maintain. Between 140 and 200 lineal feet of 1-in. pipe is common practice. For a brine temperature of 15 deg. F. (—9.44 deg. C.), an allowance of 50 sq. ft. of outside pipe surface will be found about proper. This will

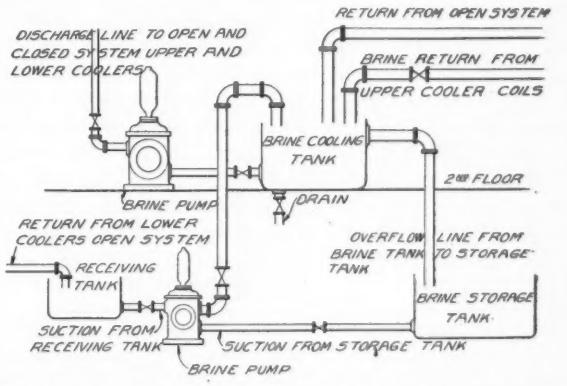

RETURN FROM OPEN SYSTEM
DISCHARGE LINE TO OPEN AND CLOSED SYSTEM UPPER AND LOWER COOLERS
BRINE RETURN FROM UPPER COOLER COILS
BRINE COOLING TANK
2ND FLOOR
BRINE PUMP
DRAIN
RETURN FROM LOWER COOLERS OPEN SYSTEM
OVERFLOW LINE FROM BRINE TANK TO STORAGE TANK
RECEIVING TANK
BRINE STORAGE TANK
SUCTION FROM RECEIVING TANK
SUCTION FROM STORAGE TANK
BRINE PUMP

DIAGRAM SHOWING RELATIVE LOCATIONS OF BRINE COOLER, STORAGE AND RECEIVING TANKS

amount to 150 ft. of 1-in. pipe, 115 ft. of 1¼-in., or 80 ft. of 2-in. Two-inch pipe is very seldom used in brine tanks, as the coils are usually made up by bending the pipe instead of using return bends, and for close bending 1 or 1¼-in. pipe is the best.

A nipple and valve should be placed in the bottom ammonia header of the coils, so that oil or other foreign substances may be drawn off.

In case of a leak in any of the ammonia piping in the tank, care must be exercised not to draw brine into the system when pumping out the ammonia. When a leak occurs in a direct expansion system, and air is drawn in, it is not a very serious matter, as the air can be purged out from the ammonia condenser. When a leak is noticed in a coil or flange near the bottom of the tank, it is proper, when pumping out the ammonia, to take into consideration the depth of the brine and the corresponding pressure exerted by this weight. Do not pull a vacuum on the coils, for if brine is gotten into the system, it is almost impossible to get rid of it; rather, blow some ammonia gas out in the air, than take chances of drawing in brine.

Coils in a brine tank must be blown out with steam and air whenever necessary, the same as the coils in an ice tank. The frequency of this internal cleaning will depend almost entirely on the type of ammonia compressor that is used, as that controls the amount of oil that is likely to pass into the piping. Some plants steam the coils every winter, while others do not need this except every 3 or 4 yr.

### Brine Storage Tanks

The brine tank must at all times have sufficient brine in it to cover all the coils. Uncovered coils not only cut down on the efficiency, but also the action of the air will cause corrosion of the iron and leaks will develop. A float should be arranged so that the height of the brine can be known at all times without looking into the tank.

Of course, there is never enough room in the tank for all brine that is in circulation through the coolers. A large amount of the brine is out in the coils or being pumped through rooms of the open system. Proper precautions must be taken to handle this full volume of brine in case of accident. If the circulating pump should break down or stop for any reason, a lot of brine will return to the tank and overflow if no provision is made either to check the flow or store the brine. Valves are usually placed on the return lines from the coils, and these can be shut and so hold the brine back.

TABLE I. PROPERTIES OF SALT SOLUTIONS

| Degrees on Salometer at 60 deg. F. | Specific Gravity at 39 deg. F. | Specific Heat | Freezing Point. Degrees Fahrenheit. |
|---|---|---|---|
| 10 | 1.019 | 0.980 | 28.6 |
| 20 | 1.037 | 0.960 | 25.2 |
| 32 | 1.061 | 0.919 | 21.2 |
| 40 | 1.076 | 0.892 | 18.7 |
| 48 | 1.091 | 0.874 | 16.0 |
| 60 | 1.115 | 0.855 | 12.2 |
| 80 | 1.155 | 0.829 | 6.1 |
| 96 | 1.187 | 0.795 | 1.2 |
| 100 | 1.196 | 0.785 | 0.5 |
| 104 | 1.204 | 0.771 | -1.1 |

In any of the types of the open system, valves cannot very well be used on the return lines, for that would cause overflowing in the chill rooms, with a resultant damage to the goods stored.

An overflow tank is the proper thing in this case, so that the brine will first fill the brine tanks and the rest will overflow into a sufficient sized storage tank. This storage tank is also connected to the suction of the brine pump, thus the brine can again be put back into the system.

These storage tanks are in nearly constant use where a large amount of brine is circulated at times, and where coils are being shut off or turned on at almost any hour by men who handle the chill rooms and only come down to the engine room 3 or 4 times a day. If there were no storage tank, the coils in the brine tank would be exposed at times, and at other times the brine would overflow. Perhaps part of the day the amount of brine needed in the chill rooms is small, and the storage tank will be full, and then the floats must be watched so that when more coils are turned on, the necessary amount of brine is put into the brine tanks. When several brine tanks are used together for the same work, the level of the brine in the different tanks is controlled by regulating either the return valves from the coils or the suction valves between the tanks and the pumps.

The most common form of brine circulation is to have the coils arranged either in the rooms to be cooled or in pipe decks above the rooms. In the first case, galvanized iron troughs are placed under the coils to take care of the dripping water when the frost melts. The coils are kept free from frost by using alternate coils and allowing some to melt off.

Circulation is not always controlled with the inlet valve to the coil. Better results are obtained by leaving the inlet valve wide open and handling the flow of brine with the outlet valve. This is a good way, since there is less chance for a coil to become air bound and it keeps just about the same amount of brine out in the system at all times, whether the coils are in use or not. It also keeps the pipe full of brine and gives more efficiency than if the pipes are only partially filled. Admitting the brine to the bottom pipe of the coil answers the same purpose as regulating with the outlet valve.

What is commonly termed "slushing" is found necessary to remove frost from coils that cannot be allowed time to melt. To slush a set of coils, it is necessary to have warm brine. A separate tank, without ammonia coils, should be used in which the brine is heated with steam and then pumped through the coils till the frost or ice drops off. Slushing also recovers any salt that has become lodged in the pipe work.

TABLE II. PROPERTIES OF CALCIUM SOLUTIONS

| Degrees Baume | Degrees Salometer | Freezing Point Degrees Fahrenheit |
|---|---|---|
| 1 | 4 | 31.20 |
| 5 | 20 | 28.00 |
| 10 | 40 | 22.09 |
| 15 | 60 | 13.82 |
| 18 | 72 | 7.66 |
| 20 | 80 | 3.12 |
| 21 | 84 | -0.84 |
| 25 | 100 | -15.23 |
| 27 | 108 | -24.43 |
| 30 | 120 | -41.32 |
| 32 | | -54.00 |

### Open Brine System

Next to the coil system in most common use come the several different types of the open brine system. It is just what its name implies. The brine is not confined in coils, but is flowed in sheets over curtains or direct expansion piping or sprayed directly in the pipe deck. The curtain type consists of sheets of cloth hung vertically, or sheets of galvanized iron or even boards slightly inclined and the cold brine flowing over the surface. Saw-tooth troughs or perforated pipe are used to distribute the brine evenly over whatever style of curtain is used.

The flow of brine is regulated by suitable valves controlling either one or several curtains. The return brine in this, as in all other open systems, drops to the floor or into pans and flows by gravity back to the brine tank.

Where the open system is used in a cellar which is too low to allow the brine to flow back, an extra tank must be installed to receive the brine and a pump must be used to put it into the brine tank.

Sometimes the pipe deck of a cooler is fitted with direct expansion coils, and a sheet of brine is also used,

flowing over the coils. This is a very efficient manner for quick cooling. The brine keeps the direct expansion coils entirely free of frost and the brine also returns to the tank much cooler than it does in cases where curtains are used.

Another style for the open circulation of brine is the spray system. The inlet brine header is placed at one end of the cooler pipe deck and branches provided with valves are extended the length of the room. These branches are provided with small drilled openings or else with pet cocks spaced 18 in. or 2 ft. apart. A small spoon-shaped deflector is fastened close to the opening so that the brine is sprayed in a thin sheet instead of a small stream. The brine is returned in the same way as in the curtain system.

Open systems are much more efficient and quick than the coils, as the brine comes in direct contact with the air from which it takes up heat. There is no frost to contend with, no air-bound or blocked coils, and the cost of installation and maintenance is as low as it possibly can be. Slushing of an open system will recover all salt that has been disposed on curtains or floor of pipe deck.

### Use of Fans

The fan system is identical with the same type in the direct expansion in some cases; but usually where the fan circulation is in use, the open brine system or the combination of both open brine and direct expansion are used. The brine in such cases is allowed to flow over the banks of direct expansion piping. This brine also acts as an air purifier or washer, for any impurities taken up by the air in the coolers are absorbed by the brine.

The brine system is preferable to the direct expansion in places where the ice machine is shut down at night during part of the year. The chill rooms or cold storage are held at their proper temperature during the night by allowing the brine pump to circulate the brine, even while the machine is shut down. During the day, the machine runs at full capacity and in that way the large body of brine is brought to a low temperature. In case of the ice machine breaking down so that it cannot be run for even as long as 48 hr. in the middle of summer, it is still possible to keep all the product in storage from spoiling. Ice and salt can be used in the brine tank and a sufficiently low temperature maintained and the brine circulated as usual.

When extreme low temperature is required, calcium brine is used instead of salt because it will not congeal when subjected to low temperature. It is also claimed that the corrosion of the iron of the coils and tanks is much less when using calcium, but the difference is so small as to make scarcely any difference. Calcium is nearly always used in places where double or triple-pipe coolers or shell coolers are installed.

In the double-pipe cooler the principle is the same as in the double-pipe condenser, the calcium flowing in the opposite direction to the expanding ammonia. The solution is in the inner pipe and the vapor between the inner and outer. These coolers are placed in a cold room as otherwise the ammonia will take up heat from the atmosphere as well as from the calcium. In some places they are placed directly in the tank containing the calcium. This manner of installation calls into use every square inch of cooling surface and is found to be very efficient.

The triple-pipe cooler is the same as the double pipe with the addition of another outer pipe through which but instead of having tubes it is provided with coils. The shell cooler is made up of a shell like a tubular boiler, but instead of having tubes it is provided with coils. The ammonia is admitted into the shell close to the bottom and the gas passes to the compressor from the top. This is worked on flooded system and a gage glass is provided to note the liquid level. The calcium enters the coils through a manifold at the top and is taken into the circulating pump at the bottom. The outside of the shell is well insulated and generally finished with a lagging of narrow, neat appearing boards with bands around to hold them in place.

Danger of freezing is great in all 3 types of calcium coolers. The strength of the solution must be watched and also the circulation. If the pump stops for even a short time the calcium is likely to freeze and split the coils or pipe. It is not good policy to attempt to use salt brine in connection with coolers of this kind.

When cold storage rooms are handled in connection with an ice making plant, the calcium or salt brine is pumped from the ice tank through the coils in the rooms and returned through the cooler. This allows the returning brine to be discharged into the tank at a low temperature and does not interfere so much with the ice making. Discharging from the ice tank through the cooler and returning direct from the rooms is not the proper manner of operation, although this is often done. The exchange of heat is not so great, consequently the cooler is not so efficient.

### Comparison of Brine and Direct Expansion Systems

An inclosed brine system is more expensive to install than a direct expansion system, owing to the greater amount of pipe required; but much less ammonia is used and the ice machine can be made to do better work, as the expansion valves are more handy and directly under the control of the engineer. In the direct expansion system, the compressor will be getting return gas from coils placed in rooms varying in temperature from 15 to 50 deg. F. above zero (—9.44 to +10 deg. C.). In the case of brine, the gas from the coils in the tank is uniform.

The amount of pipe used in both systems is greatly different. The exchange of heat between the ammonia in a direct expansion coil and the atmosphere in the chill room is much greater than the exchange between the brine and the atmosphere. This accounts for the greater amount of brine circulating pipe necessary. The number of feet of pipe will also vary according to the temperature at which the room is to be held. A well insulated room of about 10,000 cu. ft., that is to be kept at a temperature of 32 deg. F. (0 deg. C.), would require one lineal foot of 2-in. brine pipe for every 15 cu. ft. of space, while if the same room were to be held at 5 deg. F. (—15 deg. C.), twice as much pipe would be required. This piping is what is allowed for holding the temperature of the room, and more pipe must be added to take up the heat given off by the produce put in storage.

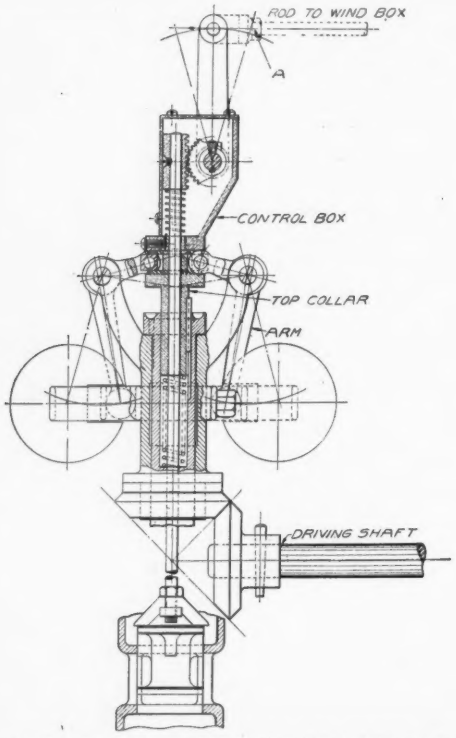
# LETTERS DIRECT FROM THE PLANT

*Cash Paid For Ideas Accepted. Sketches Desirable.*
*We Make The Drawings*

## Governor for Stoker Engine Control

IN THE accompanying illustration is shown the construction of the Waters governor as designed for stoker engine control. The governor is arranged to regulate the engine through changes in load or operates through changes in wind box pressure.

The regular type of governor has the upper portion of valve stem threaded which engages with a threaded portion of top collar. Any movement of the balls tends to move the top collar and consequently the valve, too, as it is attached to the stem.




CROSS SECTION OF WATERS GOVERNOR FOR STOKER ENGINES WHEN FORCED DRAFT IS EMPLOYED

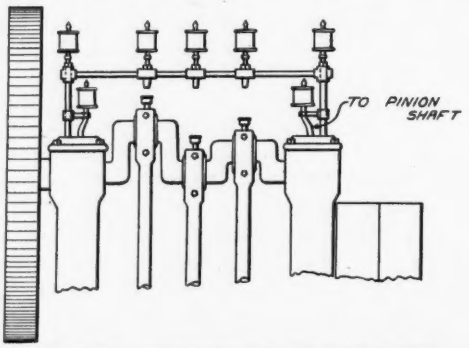
In the wind control type of governor the stem is not threaded but slides freely through the top collar. A rack is attached to upper end of the stem which engages with a gear sector fastened to a shaft passing through the control box on the end of which a lever is fastened. If the wind box pressure changes, it is communicated through the lever to sector and rack and valve is moved irrespective of governor speed, so that the engine is controlled by the wind pressure and governor balls have no effect. If the wind box pressure does not vary, the lever will remain stationary (excepting for up or down movement). With the lever stationary the sector, rack, stem, top collar, etc., will move as one piece, so for variations in engine speed the whole mechanism would be subject to changes of ball position and the engine would be controlled by governor. In actual practice a combination of the above, no doubt, occurs. By moving lever to position A it would give maximum opening of valve with governor balls at rest. To keep the engine under control of the governor at all times, the governor is arranged to close the valve before the balls reach their extreme outer position and with stem in its extreme upper position in the control box.

H. A. AUSTIN.

## Triplex Boiler Feed Pump Saves Fuel

ON TAKING charge of one of the plants over which the writer has supervision, it was found that the feed water was supplied to the boilers by 3 large compound duplex steam pumps, 2 in continued use, the third and 2 injectors held in reserve.

The discharge from the traps in the various heating lines, ran into a tank which also received the make-up water, the temperature averaging 90 deg. F. The water gravitated to the pump which forced it through




OILING ARRANGEMENT FOR TRIPLEX PUMP

the heater between the low-pressure cylinder and condenser in which the temperature was raised to 122 deg. F., and then through another heater which utilized the exhaust from the fan and stoker engines and the pump, the temperature or discharge being 210 deg. F.

Tests were made to determine the steam rate of the pumps and it was found that the exhaust from the auxiliary engines was all that was necessary to raise the temperature in the heater to the maximum and then little exhaust escaped through the exhaust head.

It was decided to move the tank mentioned near the

engine room, which enabled the discharge pipe of the several traps to be shortened. A triplex power pump was installed, of such size that it could run slowly, and was driven from a pulley mounted on the engine crank shaft.

The water flows by gravity to this pump and thence over the course described. The bypass with which all such pumps should be provided, had an extension to the spindle made so as to be within easy reach of the firemen on the firing floor, enabling the supply of water to be adjusted according to needs. It was found that a little more than 1.5 ton of coal per day of 10 hr. was saved by the change.

Lubrication of power pumps is an important detail of operation that usually is sadly neglected, as testified by the general condition of such pumps in use. This one had about a cup of oil put in the hollow plungers to lubricate the wristpin. The small cups screwed into the connecting rods were removed and wipers made, together with a stand to support the oil cups for the pins and bearings, as shown in the figure, from pipe fittings. RECEIVER.

## Saving the Drops

THE QUESTION brought up by Mr. Near, in the April 15 issue, of "How many drops is the correct number?" is of more than passing importance, and one in which there may be more than one correct answer.

The test which he mentions, of noting the length of time required for the engine to stop after the throttle is closed, is interesting, and true in so far as it applies to one particular engine operating under exactly the same conditions in each case, but would be of little value for anything more than the comparison of 2 different oils under the same conditions, and even then the data obtained would be liable to errors.

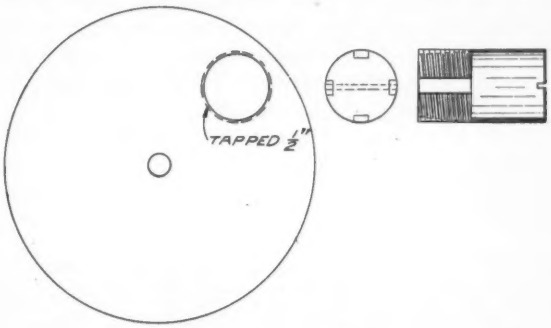
The stopping time is simply the length of time that is required for the friction in the bearings, crosshead, cylinder, etc., to overcome the momentum of the flywheel and other revolving part, and the degree of cylinder lubrication has but a small comparative influence on this time. There is a great difference in cylinder oils, and sometimes, even in different barrels of the same shipment. Our oil is purchased by the purchasing office on bids submitted for a yearly supply and, as a rule, the oil used one year differs from that used other years.

There is, in my opinion, only one reliable method of determining the proper amount of oil to pump into any cylinder in a given time, and that is by actual inspection. Run the engine for say, a week using the amount of oil that in your judgment is adequate to lubricate the cylinder without any cutting. At the end of the week take off the chest cover and cylinder head and examine the wearing surfaces. If the surfaces show a brown coating with no bright spots, and will soil a piece of white paper rubbed over the surface, it is getting enough oil and more would be wasted. If there are bright spots, increase the feed within a reasonable limit and run another week. If on the second examination no improvement is found, either the oil is unsuited for the conditions or it does not reach the surface in the proper manner. When too much oil is used, it will be apparent from the condition of the cylinder. This inspection, of course, takes time; but the information gained from these examinations can be relied upon to give the true conditions of the cylinder lubrication.

Whenever a pump or engine piston or valves groan, it is customary to speed up the oil pump which, if the cylinder shows that not enough oil is being used for good lubrication, is the right method; but in most cases where a reasonable amount of oil is used, the trouble is more often due to the manner in which the oil is distributed to the cylinder, wet steam or water washing it off; or the rings may be stiff and worn loose in the grooves which will cause them to groan and chatter, and the edges of the ring may be worn sharp, which will scrape the oil off instead of riding up over it as it should. It is suprising in how many instances where trouble is experienced from valves or pistons goarning, it will be found that the oil instead of being discharged into the center of the steam pipe, preferably into the vertical pipe or through a perforated pipe extending nearly across the steam pipe, simply runs down on the inside of the pipe and thence by the most direct route, together with the condensation to the exhaust pipe. If the steam is wet, due to frequent priming, or the pipe not properly dripped, it will wash the oil off, and oil of a different grade may give better results. J. C. HAWKINS.

## Governor Gagpot Repair

TO REGULATE the action of a governor gag pot, I have used the following scheme to good advantage. Bore a hole in the follower plate, as shown by the sketch, and tap it for ½-in. plug. A plug is made of solid material and threaded so it will screw in moderately tight. Slots




FOLLOWER PLATE AND PLUG FOR GOVERNOR GAG POT

are cut in the threaded end, giving it an appearance somewhat like a taper reamer; a slot is also cut in the top so the plug can be adjusted with a screw driver.

F. V. BROADAWAY.

## Trouble with a Boiler Feed Pump

ONE OF our boiler feed pumps had been working badly for some time. It is a double-acting, end-packed, plunger type. It began to develop a lot of pounding and knocking, leaked around the plungers and blew its packing continually. After trying several well-known brands of packing and finding that none would hold, we made a careful examination of all parts of the pump and measured the plunger diameter carefully with calipers

and scale. We found that the diameter of the plunger was no longer uniform throughout its length, but the plunger had worn until it was slightly tapered. The plungers were removed, placed in a lathe and machined up to cylindrical form. After they were replaced and repacked, the pump worked as well as ever and almost any kind of packing would hold. R. S. HAWLEY.

## Engine Stop System

FOR SOME time I have been advocating the installation of an engine-stop system in our plant; but business has been so bad that my employers have not felt able to afford the system I have recommended. A recent accident, however, brought out the fact that we had to have

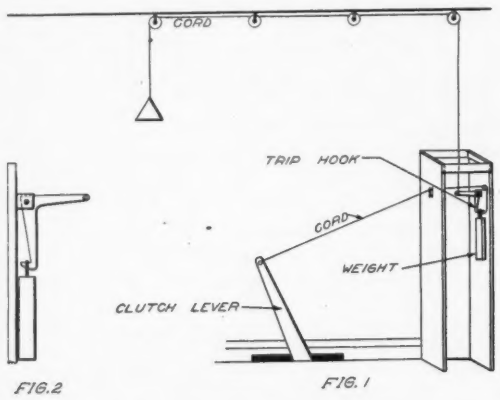



FIG. 1. SKETCH OF ENGINE STOP
FIG. 2. DETAIL OF TRIP HOOK

some method of shutting off the power without depending upon the engineer. While doing some minor work on our main clutch (friction clutch), I worked out the following idea, which has proved very successful.

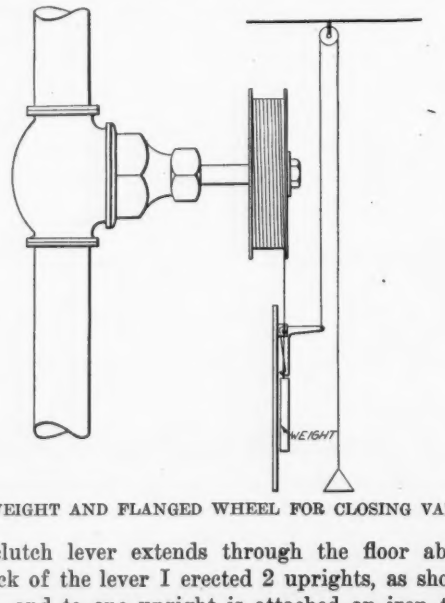



FIG. 3. WEIGHT AND FLANGED WHEEL FOR CLOSING VALVE

Our clutch lever extends through the floor about 4 ft. Back of the lever I erected 2 uprights, as shown in Fig. 1, and to one upright is attached an iron trip hook, as shown clearly in Fig. 2. From the upper arm of this trip hook, a cord extends the length of the mill, passing over the principal machines in the shop; from the main cord extensions are dropped to each machine, thus allowing each operator of a machine to have control of the clutch while working at his machine.

The operation is this: When the cord is pulled, the hook of the trip-hook is pulled up releasing the weight (see Fig. 1), and allowing it to fall; as the weight falls by its chain connection to the clutch lever, it pulls the lever over, throwing out the clutch.

I have also worked out this idea, and am using it in connection with a stop valve, between the vulcanizers and the boiler. If the cord is pulled (see Fig. 3), the trip hook will release the 50-lb. weight, and being connected to the flanged pulley on valve stem by a chain, will cause the pulley to revolve, shutting the valve and hence the steam off. I have found that in devices of this sort, chain is more reliable than rope or cable and is not so liable to stretch. ARTHUR D. PALMER.

## Results of Flue Gas Analyses

WE HAVE recently installed at our plant the Hays Gas Analysis Apparatus for analyzing the boiler gases and have been getting good results.

Before installing the outfit, which consists of the gas collectors, draft gages and analyzer, we had to guess about where to operate the dampers and we have since found that we were using a large amount of excess air.

The first samples of gas I took from the last pass of the boilers showed 10 per cent $CO_2$, which means about 5 per cent fuel loss which would amount to a great deal of money in a year.

After getting the settings tight and the dampers regulated to a draft of 0.15 in. over the fire, we obtained an average of 13.6 per cent $CO_2$, a gain of 3.6 per cent and only about 1 per cent fuel loss. The analysis showed only a trace of CO.

We carry the same load on the turbine as before and where we burned an average of 200 bbl. of oil in 24 hr., we now do the same work with 185 to 190 bbl., which is quite a saving.

There is a gas collector on each boiler and I take a sample from each and analyze it for $CO_2$ every 12 hr. This gives the average $CO_2$ for the 12-hr. run and keeps a good check on the fireman. You would be surprised to see the difference in the men now, each one working to get the highest $CO_2$ and as it goes on the daily report sheet which the superintendent gets every morning, they all want a good average, so it keeps them busy all the time.

The draft gages give them a check on the draft over the fire all the time and they are a great help. We couldn't get along without them. D. J. WOLLAM.

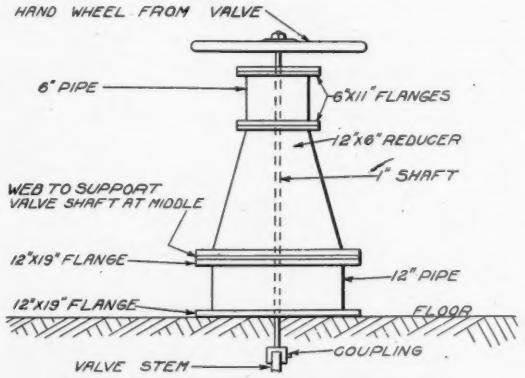
## Copper Gasket Used as Piston Ring

I ONCE HAD under my care a plain slide valve engine with sectional piston rings, and the joint between the engine frame and cylinder leaked badly. I sent to the factory and secured a copper gasket to insert, then pulled the piston from the cylinder, and in so doing one of the sections of the back ring fell into the steam port opening. I looked for this section but could not find it, so I supposed it had been run that way, as there had

been a careless man in charge when I took this plant, and ordered a new ring. In the meantime, we needed our power and I put in the copper gasket, placed the piston in and put on the head. I then turned the engine over by hand and found it to be O. K. I then gently turned the steam on, and the engine made several revolutions when something went (bang) and the engine stopped at once, the steam had blown out the section of ring and the piston struck it. This jam sprung the strap over the wrist brasses forward, the top of the wedge being about halfway up the strap on the out end causing the strap to buckle ahead, giving the piston enough play ahead to have knocked out the front cylinder head. It did not, however, and my idea why it failed to do so is that the lead on the valve leaving unexpanded steam at the opposite end, full of expansive power, was able to overcome the expanded steam driving the piston and the momentum of the reciprocating piston, stopped the piston from striking the front head. I did not know the strap was sprung till I started the engine up or I would not have started, and I think the accident spoken of in the Apr. 15 issue, page 386, would have acted the same way. G. H. S.

## Homemade Floor Stand

HEREWITH is a sketch showing how we devised a very cheap but satisfactory floor stand for operating a large gate valve located below the floor line. This stand




FLOOR STAND MADE FROM PIPE FITTINGS

was made of fittings found about the plant, and after having a coat of black enamel paint, presented a first-class appearance. M. SALLER.

## Distilling Water on Board Steamers

ON ALL ocean going steamers that carry passengers, and on all ships of the navy, there are evaporator and distilling plants, where the sea water is evaporated and distilled into fresh water. The capacity of these plants is generally sufficient to supply all fresh water for drinking, cooking and bathing purposes, also part of make-up feed water for the boilers.

All ships carry reserve feed water for boiler use, and usually distill only necessary water, to keep the amount in the reserve feed tanks at a safe margin. Distilled water is expensive; not only the cost of fuel burned to furnish the steam used, but the upkeep of the plant, makes the price per gallon distilled, enormous, when the records of the plant are well kept and the total output in gallons are divided into the cost of fuel, material, repairs, labor, etc.

The plant under my care is provided with 3 evaporators and 3 distillers, one distiller flushing pump, 2 evaporator feed pumps, a feed heater, steam separators and traps. The evaporators have a combined capacity of 23,000 gal. per 24 hr., when used in single effect. The distillers have a combined capacity of 10,000 gal. of potable water per 24 hr. The evaporators are so arranged that they may all be operated in single effect, or the high-pressure evaporator may be used, with either of the others as low-pressure, in double effect.

When working in single effect, all the evaporators take steam from the boiler auxiliary steam line, and the evaporator steam coil drain pipes lead through and bypass automatic steam traps to the feed tanks. There is on the shell of the high-pressure evaporator, a connection with the necessary valves and pipes, for directing the steam generated there into the steam coils of either or both the low-pressure evaporators, into the distillers and into the exhaust line leading to the condenser plant. The shells of the low-pressure evaporators have connections with valves and pipes, for leading the steam into the distillers and into the exhaust line leading to the condenser plant.

Feed water for the evaporators is taken from the circulating pipe, after it has passed through the distillers, and from the sea.

There are blowpipes or blow-down lines of ample size at the side and near to the bottom of the shell, so that the brine pump may draw from the evaporators and discharge overboard, or that the evaporators may be blown out when working under pressure.

When the plant is operated in double effect, the vapor or steam that is generated in the high-pressure evaporator is directed through the steam coil of the low-pressure evaporator; after passing through this coil, it is directed to the distillers.

The vapor or steam from all evaporators can be passed through the feed heater on its way to the distillers, thus giving fairly hot feed to the evaporators. The distillers, after cooling the vapor to water, discharge it into measuring tanks and from these it is pumped to the various tanks as needed.

Each evaporator has a tube coil composed of 2-in. brass tubes No. 12 B. W. G. having a total of 390 sq. ft. of heating surface. The tubes are expanded into tube sheet header at one end and screwed into return bends at the other; the coil and header are bolted to the shell, so that after the tubes become scaled the coil is able to be withdrawn and cleaned.

After 3 weeks continuous operation, the coils must be taken out and cleaned free of salt scale, as the evaporative efficiency is much reduced; and when salt scale is being removed, care must be used that the tubes are not made to leak by the hammering off of the scale. The coil must be tested each time for these leaks, for if steam from the coil leaks into the shell it makes the water distilled taste greasy or oily, as the steam in the coil comes from the boiler plant.

The steam pressure carried on the coil of the high-pressure evaporator is 40 lb., and this gives 15 to 20 lb. on the shell. That is the pressures used when

running them in the single effect. When running them in double effect 50 lb. is carried on the coil of the high-pressure, this gives 32 lb. on its shell, then this pressure led into the coil of the low pressure evaporator gives 25 lb. on the coil and about 12 lb. on its shell.

When running the plant in the single effect we keep the coil drains nearly closed. Each coil is fitted with a gage glass in the tube sheet header and, with the coil drain valve, the amount of water kept in the bottom of the coils can be regulated; this prevents live steam being wasted without giving off its heat.

It is impossible to supply all the demand for fresh water on board ship, as the boiler power would have to be greatly increased and space on board for tanks would be better used than space for additional boilers with their coal bunkers. C. H. WILLEY.

## Record Blank

WHEN I took charge of my present plant, after having some meters, etc., installed, I designed the accompanying daily report sheet.

This form is for a 250-hp. plant, but is good for much larger.

W. N. CLARK COMPANY

Power Plant Daily Report — Date — 191

| SKINNER | | FRICK | | | | TEMP. STORAGE | |
|---|---|---|---|---|---|---|---|
| Start | Stop | Start | Stop | R. P. M. | Temperature | Start | Stop |
| | | | | | "A" Storage | | |
| | | | | | "B" Storage | | |

| | | | COST | |
|---|---|---|---|---|
| Boiler in Use, No. | | | | |
| Coal Used—F B Bwt. | lbs. | | | |
| N/S | lbs. | Total lbs. | | |
| Ash | lbs. | | | |
| % Ash | | | | |
| Water Meter Reading | Cu. ft. | | | |
| Temp. Feedwater | deg. | | | |
| Total Water Evaporated | lbs. | | | |
| Water Evaporated per lb. of Coal | lbs. | | | |
| Kilowatt-Hour—Meter-Reading | | | | |
| Total Kilowatt Hours | | | | |
| Evaporation per Dollar | | | | |
| Plant Wages—Engineer | | | | |
| Fireman | | | | |
| | | | | |
| Remarks | | Engine Oil | | |
| | | Cylinder Oil | | |
| | | Skinner Oil | | |
| | | Ammonia Oil | | |
| | | Blr Graphite | | |
| | | Waste | | |
| | | | | |
| | | | | |
| | | Supplies Received—Coal, Etc. | | |
| Live Steam on | | | | |
| Live Steam off | | | | |

Engineer

RECORD BLANK USED IN SMALL PLANT

We have tested different kinds of coal and found the most economical for this plant by this report and could hardly get along without it now. I hardly think my employer would want an engineer who could not keep it up, for he finds it very interesting.

C. M. BOURCY.

## Belt Insurance

IT IS SAID that Ponce de Leon didn't find his magic spring; and we all believe it. Life cannot be sustained indefinitely by simply washing or stuffing ourselves with some magic substance, because, as far as we know, there are no magic substances; so, we can conclude that if Ponce de Leon had taken good care of himself instead of searching for the impossible, he would have lived longer than he did.

The same is true of equipment such as we use in our everyday lives—shoes, hats, suits, power plant equipment, etc. Take belts, for instance. Belts are usually considered very perishable, and if allowed to slip, burn, dry, crack, grind, run off, run too tight, or get wet, they certainly *are* perishable; but all of these things are unnecessary, for a belt can be cared for as well as the human body in order to make it reach a good, ripe, useful old age. Belts needn't slip, burn, and run off. They needn't dry, crack, or get wet. Great initial tightness is unmechanical and foolish. Treat the belt with a good belt treatment, something that will penetrate the belt, get into every pore, surround every fiber, lubricate, make the belt pliable, keep out water, prevent drying, cracking and chafing, and, best of all, stop the slip as long as the belt is kept treated. The creep which is practically negligible but inherent in all belts is the only wear factor worth considering.

Are your belts running too tight? Do they slip? Are they wearing out rapidly? Do they run off? Does moisture affect them? If so, get after them. Don't look for something magic, as Ponce de Leon did, but make the most of what you now have. N. G. NEAR.

## Engine Accident; Cylinder Lubrication

IN THE letter by L. K. entitled, Peculiar Engine Accident, he does not state what type of engine nor what type of connecting ends are on the damaged engine; but as he says that the lower bolt broke and the upper one bent, I take it that the connecting rod is of the type where adjustment of the crankpin box is made by a wedge, drawn up or relieved by means of draw bolts which oppose each other on the wedge and lock the adjustment. If it should be a rod of this type, I do not believe that the breaking of the lower bolt was the cause of the accident, as this would not allow enough lost motion here to knock off the cylinder head; but I would sooner believe that the accident was caused by the piston parting from the piston rod.

N. G. Near in the same issue, page 385, gives us an idea how to find the correct amount of lubricant to be used in a steam engine cylinder, which is by the "fly-wheel test." I believe this idea does not hold good in all steam engines. I have found in my practice that about the only way to make sure that the cylinder, piston and valves are getting enough oil is by hearing, feeling and examining. By this I mean should you take charge of a strange plant or run in a new engine, it is best not to be too saving in oil for the first few days. During the meantime feel the valve rods to see if the valves are working smoothly; also place a pencil or stick at some part of the cylinder, placing the other end in your mouth, closing the ears with the fingers, you are able to tell whether the piston and cylinder are getting enough oil. If not, you will hear a groaning noise. Then, at the first opportunity, open the cylinder, also examine the valves (but before doing this, count the number of drops you are feeding at the present time). If, in your judgment, too much oil has been fed or not enough, reduce or increase the number of drops until the right amount has been found, examining the cylinder, piston and valves a few times during this time.

H. A. JAHNKE.

# Questions Answered and For Answer

*Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp*

## Answers to Ohio Examination Questions*

A BOILER SUSPENDED by hangers is free to expand and contract without affecting the brickwork of the setting. While a boiler properly supported on the brickwork with roller, to take care of the motion, will work without cracking the setting, it is freer to move if supported by hangers, and, also, any settling of the brickwork does not tend to throw the boiler out of level, and replacing of the brickwork is more easily done.

11. Too little lost motion on steam pump valves will shorten the stroke, and vice versa.

12. Incline the steam line toward the engine, and put a good separator at the engine to take out the moisture. This moisture will not drain back to the boiler against the flow of the steam.

13. Almost any answer might be given, as there are a dozen things that ought to be considered in piping a steam plant. The 3 that come to our mind first are: safety, provision for expansion and drainage. Somebody else might choose some other 3. To take care of expansion in a steam line, see the Jan. 1, 1913, issue, page 7.

14. The changing temperature of the furnace puts more strain on the sheets of the boiler than does the steam pressure. You can see that this is the case if you will consider the results. Even the greatest permissible pressure on a boiler is not sufficient to change its length materially, while the change in temperature from cold to hot in a boiler produces sufficient change in length so that it is necessary to provide for this expansion in starting the boiler.

15. Recent experiments tend to show that boiler steel has its maximum tensile strength at 250 to 300 deg. C., so that under ordinary working conditions the metal is stronger under steam pressure than under cold water pressure.

16. There is some difference of opinion as to the circulation of water in horizontal return-tubular boilers, but we think that most engineers agree that the circulation is up in the middle of the boiler, at the front end, back along the top of the boiler, down at the rear of the boiler and at the sides. In horizontal water-tube, the tubes are inclined upward towards the front, the water passes upward in these tubes, up through the front headers, or tube sheets, back in the steam drum and down through the rear tubes.

17. For horizontal return-tubular boiler settings, get plans from the Hartford Boiler Inspection & Insurance Co. For water-tube boilers, get the plans from the manufacturers of these boilers.

18. See the Jan. 1, 1915, issue.

19. The water cylinder can be made longer than the steam cylinder in a pump because it is not essential that the clearance should be small. There is no particular loss with a slight excessive clearance in the water cylinder, and a little excess of volume here gives quieter working of the valves.

20. Repair of the piston rod on a duplex pump would depend entirely on how the break occurred. No general directions could be given.

21. A piston striking the head of a pump means that the stroke is too long. The lost motion in the valve action should be decreased.

22. If there is a bad leak of water past the piston or plunger of a pump, it would be necessary to drive the pump at a good deal higher speed than normal in order to get the required service. If there is a water meter in the line, the reading of this meter can be compared with the computed water pumped, but a difference here may be due to leakage past the piston or through the valves. A bad leak can usually be heard by listening close to the water cylinder. If the leak is small, or if the pump is running very slowly, this can not probably be detected.

23. The easiest way to find out about a check valve is to take it apart. A guess as to its condition might be made by listening to the valve when the water is not being forced through it, to see whether any back flow can be heard; but if the pump valves are tight, the pump may hold and prevent any such back flow.

24. We do not understand what is meant by this question except as it applies to pump suction; if the pressure be removed from the top of the water in the pipe the air pressure will force the water up into the pipe.

25. See Jan. 1, 1916, issue.

26. A condenser is used, first, to lower the back pressure on a steam engine, which increases the temperature range and therefore, the possible efficiency; second, in a surface condenser, where water suitable for water feed is scarce, and there is plenty of water such as salt water or muddy river water available for cooling, the condenser permits of using the same water over and over again in the boilers.

27. In changing an engine from non-condensing to condensing, no changes need be made if the valves were set right running noncondensing. It would, however, be well to have the cutoff come earlier, unless the load is increased when the condenser is started, otherwise the speed will be increased to some extent, depending upon the type of governor.

28. A common slide valve is not necessarily always a balanced valve. Some slide valves are provided with

*Continued from page 470, May 15 issue. Questions were published on page 931, Oct. 1, 1915, issue.

plates whereby the pressure is equalized on both sides of the valve. Ordinarily, however, in the small slide valve engines, the valves are not balanced.

29. The lap angle, meaning the steam lap, is the angle through which the eccentric must be rotated from its central position to cause the steam edge of the valve to travel the distance of the lap. The lead angle is the angle between the position of the crank when the valve begins to be opened, and its position when the piston is at the beginning of the stroke.

30. The steam eccentric is set 90 deg. plus the angle of lap plus the angle of lead ahead of the crank.

31. Multiply the area of the piston, in square inches, by the length of the stroke in inches, and it will give you the piston displacement in cubic inches per stroke.

32. Place the crank on the head-end dead center and shove the crosshead back toward the cylinder to its extreme position. Then the distance between the center of the crosshead pin and the crankpin will be the required distance between the centers of the crank brasses.

33. If the water should suddenly drop out of sight and not return to its normal level, the only safe procedure would be to bank the fires at once with ashes or green coal, close the draft, cut the boiler off from the line and allow it to cool off.

34. The total heat in steam at 300 lb. gage pressure is 1204.7 B. t. u., and at 200 lb. gage pressure is 1199.2 B. t. u.

A. L. R.

## Massachusetts Examination Questions on Steam Turbines*

WHAT is a baffler for?

A. It is a device to restrict the flow of oil or water to the step and side bearings.

86. Describe the baffler and how it works.

A. The baffler is a smooth cylinder fitted with a square threaded worm inside, and the distance this plug is screwed in regulates the flow as the oil must pass through the entire length of thread inserted.

87. How do you grind a step bearing?

A. Shut water or oil off for 15 sec. with turbine running ⅓ speed.

88. What is the screw in a baffler for?

A. To obstruct the flow of oil or water.

89. Is it necessary to have a baffler?

A. No, but for some machines it is desirable.

90. What is the advantage of a baffler?

A. It steadies the flow from oil or water pump to step bearing as pressure varies, and from one source of supply the pressure can be regulated as desired on any bearing.

91. If the supply for the step bearing fails, what will be the result?

A. The step bearing will probably weld together, so it would be necessary to have new bearings. Gradual wearing will cause the bucket wheels to rub on the stationary blades, and the friction will stop the machine.

92. On the Allis-Chalmers, how does the governor work?

A. This governor is of the Hartung type. It is driven by cut gear from shaft working in oil bath; this operates the balanced oil relay valve only. The 2 steam valves, main and bypass, are controlled by oil pressure of about 20 lb. acting on a piston.

93. How would you start up an Allis-Chalmers turbine?

A. Get the oil pump going until it lifts the inlet valve, develops about 20 lb. on relay oil gage and 2 to 4 on bearing gage. Warm up by opening throttle for ½ hr., then run slowly up to speed. Turn water on glands.

94. Would you run a turbine with vacuum and no load?

A. No, put load on first.

95. How do you stop a turbine?

A. Start up the auxiliary oil pump to hold the oil pressure as the turbine slows down, break vacuum when the load is nearly off, and otherwise you reverse the order of starting.

96. Why don't you run the auxiliary oil pump all the time?

A. Because when the turbine is running it runs an oil pump called a dependent pump.

97. What is the pitch of blades?

A. The distance between the edge of one blade and the edge of the one next to it.

98. What is the relative velocity?

A. The difference in velocity between that of the steam jet and the blades.

99. How is steam admitted in the Parsons?

A. On account of the drop in pressure, steam is admitted all around the wheel.

100. What is the double flow turbine?

A. The steam enters the center and blows towards both ends; this takes care of the end thrust and does away with the end thrust balancing pistons.

101. Where are double flow turbines used?

A. In large units.

102. How is the danger of broken bucket wheels overcome?

The thickness of the wheel is reduced at the rim so that the edge will let go first; this unbalances the wheel and the heavy hub strikes the sides, and friction will stop the turbine.

103. How does the throttling on a DeLaval work?

A. The governor has a spring actuated double beat valve, controlled by spring and weight governor at one end of gear shaft reduced in speed 10 to 1. The governor also operates a tappet which comes into contact with an independent valve that operates a butterfly valve in the exhaust passage; this puts atmospheric pressure on the exhaust and the turbine will not race with no load this way.

104. Are the nozzle valves on a Curtis to be worked open or partly closed?

A. They work wide open; they pop open to save cutting off the seats by wire drawing.

105. Which is the most satisfactory way of governing the Curtis?

A. All new machines are governed hydraulically.

106. How does the governor of a Westinghouse work?

A. Admission is through a double beat valve controlled by a steam operated piston above it; a heavy spring on the piston holds the valve to its seat. The

*Continued from page 354, April 1 issue.

governor gets its motion from spiral gear and eccentric from main shaft.

107. What is the action of steam in the Westinghouse?

A. The governor operates the pilot valve which in turn works the main valve, admitting steam in puffs.

108. What is a compound turbine?

A. One that has 2 or more wheels on a shaft separated by stationary guide vanes.

109. What is the object of deflectors?

A. Deflectors are stationary blades to change direction of flow; these are usually called stationary blades or buckets.

110. How do you raise the cover to examine the bucket wheel?

A. Use 2 chain slings, have a turn-buckle in one so that the cover may be raised even and not do damage to buckets.

111. What precaution must be taken in packing a step bearing pump?

A. Care must be taken that no packing gets into baffle screw.

112. How would you pack this pump?

A. Use one ring of hydraulic packing and then use flax well lubricated. W. N. L.

## Providing Proper Elevator Drive

WE ARE going to install an electric motor in our elevator and would like to know how to reduce the speed; the motor runs 1800 r.p.m. and has a 4-in. pulley. We want to drive an elevator shaft that runs 50 r.p.m., and have room to use a counter shaft, if necessary. Should we use a counter shaft, how much power would be lost in driving this shaft? H. D. W.

A. The speed reduction from 1800 to 50 r. p. m. is, as you recognize, quite heavy. The only way that this could be done in a single reduction would be by the use of a silent chain drive, and we doubt even then if it would be advisable, particularly with the loads which you will probably have to carry on your elevator. The motor would have a very severe strain to pick up the load at starting. The desirable thing would be to use a counter shaft, with a friction clutch, to throw on the load, letting the motor drive the counter shaft continuously and connecting the elevator on by throwing in the friction clutch gradually.

The total speed reduction is 36 times. By dividing this into 2 jumps, you can make a speed reduction from the motor to the counter shaft of 6 times, which would call for a 24-in. pulley belted to the motor, and then you would belt from the counter shaft to the elevator, the pulley on the elevator being 6 times the diameter of the one used on the counter shaft.

It would probably be best to put the friction clutch on the 24-in. pulley on the counter shaft. This must be a loose pulley, of course, and should have a long bearing on the shaft, as it will run idle a considerable part of the time, and must have enough bearing surface so that the wear will not be great.

The width of the belt will depend on the load that you have to carry. Your belt speed is about 1870 ft. a minute, and for a single ply belt at this speed, you will need about ½-in. width for each horsepower.

This belt drive, with a speed reduction of 6, will have a rather severe strain on the smaller pulley, and the distance between centers should be kept as great as possible without putting excessive weight of the belt on the shafting. Also, it should be kept as nearly horizontal as possible.

As to the loss in driving the counter shaft, this will depend on the load carried, but with a well put up drive, the loss from motor pulley to elevator pulley, through the 2 belt drives and the counter shaft friction, ought not to be over 15 per cent of the load, and it might be considerably less if you used shaft hangers with roller bearings. A. L. R.

## Result of Broken Governor

IF THE GOVERNOR on an old style Putnam engine broke, what would happen? Why? SUBSCRIBER.

A. Your question is somewhat vague, as no definite part of the governor is mentioned, and as any engine governor is made up of many parts, the failure of one of these several parts might affect the operation of the engine in a different way.

All engine governors have one similarity: in the state of rest the governor controls the valves for the greatest valve opening, and as the engine comes up to normal speed, the governor comes into play reducing the valve opening, or point of cutoff, as the case may be, until the governor has entire control.

Again, if anything interferes with the normal operation of the governor while the engine is running at normal speed, the governor, in coming to a state of rest through failure of its driving mechanism, gradually increases the valve travel or port opening, as the case might be, and unless the engine be provided with some safety device, or the throttle closed immediately, the engine will run away with disastrous results.

The old style Putnam engine is no exception to the general rule. The action of the governor is to move the cam levers laterally above the cams and the construction of the levers is such that while admission is constant with relation to the stroke, the point of cutoff is regulated according to the position of the cam lever which in turn is regulated by the governor to meet the demand for more or less power.

Should one of the arms break off, thus relieving the governor of the perfect balance of both balls revolving in a certain plane, the action of the remaining ball would be more or less erratic with a consequent effect on the regulation of the speed. There would be a slight increase in the speed, but this increase would assist the remaining ball to assume a slightly higher plane of rotation, which would still maintain the engine speed within comparatively safe limits. Should both balls or levers break off, the effect would be the same as if the driving mechanism were to fail entirely—a runaway engine. Should the failure occur in the yoke which straddles the cam shaft or in any of the transmission levers or rods, the effect would be the same, as the tendency of the cam lever with its restraining power removed will be to return to the point of greatest valve travel. G. H. WALLACE.

# Problems For Discussion By Readers

*What Would You Do If You Had These Conditions To Meet?*

## Proper Lubricator Connections

So MANY replies to the question asked by M. M. in the May 1 issue have been received that we give here briefly the important suggestions made in these replies relative to connecting up hydrostatic lubricators.

J. C. Hawkins does not consider either connection shown in his sketch to be the best for an engine running at steady speed, but would connect the upper or condenser connection below the throttle valve and the oil pipe into the top of the steam chest directly in the path of the steam as shown in Fig. 1. If this were not possible, he would tap the steam and oil lines both directly into the vertical steam line with both connections below the throttle if there was room. Where the engine is alternately speeded and stopped, both connections to the lubricator should be placed above the throttle to get best results.

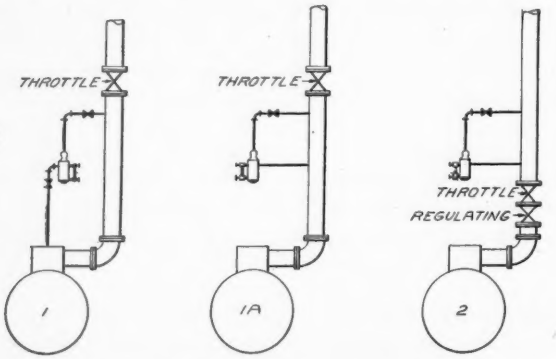



FIG. 1 AND 1A. MR. HAWKINS' SUGGESTIONS FOR CONNECTING LUBRICATOR FOR STEADY RUNNING ENGINE

FIG. 2. LUBRICATOR CONNECTIONS FOR ENGINE UNDER CONTROL OF THROTTLE

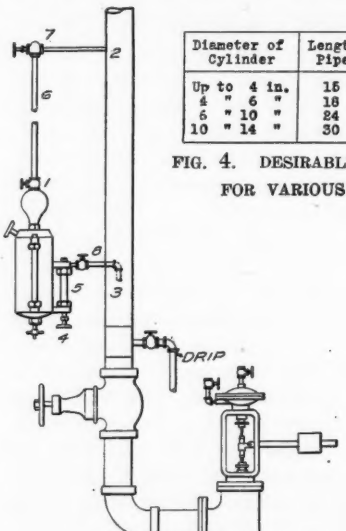
The location of the regulating valve, however, may make it necessary to place the lubricator below the valve to have it accessible for filling. Either of the above methods is preferable to connecting around the throttle, for the reason that when the throttle or regulating valve is closed the lubricator acts as a bypass around the throttle and an unbalanced pressure on the connections is added to the hydrostatic pressure which will force the oil out faster than when the throttle is open, and the feed valve can only be slightly cracked which is very likely to stop up or not feed steadily, depending on the amount of valve opening and difference in pressure.

If the case is that of a stoker or fan engine running part of the time at high speed and then with the throttle nearly closed, he prefers the arrangement shown in Fig. 2 with both connections above the throttle if possible, but if this is not possible, Fig. 1 with both connections below would be used.

Chas. Behounek thinks the proposed lubricator connections of M. M. are correct and would advise him to employ the proper valves and unions so as to be able to shut off entirely the lubricator and disconnect it for cleaning and repairs.

To insure proper mixing of oil with the steam a nipple discharging in the center of the steam pipe should be used.

As the proper operation of a lubricator depends upon the hydrostatic head of the condensed steam in the pipe, it is probable that this may not be of sufficient length.




| Diameter of Cylinder | Length of Pipe 6 | Diameter of Cylinder | Length of Pipe 6 |
|---|---|---|---|
| Up to 4 in. | 15 in. | 14 to 18 in. | 36 in. |
| 4 " 6 " | 18 " | 18 " 24 " | 42 " |
| 6 " 10 " | 24 " | 24 " 30 " | 48 " |
| 10 " 14 " | 30 " | 30 in. up | 60 " |

FIG. 4. DESIRABLE LENGTHS OF DROP LINES FOR VARIOUS SIZES OF CYLINDERS

FIG. 3. PROPER LUBRICATOR CONNECTIONS TO STEAM SUPPLY LINES

Should local conditions prevent increasing the length of this line, the use of a condensing coil will aid materially.

If for some reason one lubricator connection must be made to the steam pipe between the boiler and the throttle valve and the other between the throttle and the engine, a special so-called locomotive double-connection sight feed lubricator should then be employed. Such a lubricator is especially made in a manner that the oil cannot leave the reservoir when the throttle is closed. Directions for connecting and operating such lubricators may readily be obtained from the manufacturers.

Receiver is of the opinion that in all cases the 2 connections to the lubricator should be above the throttle

as shown in Fig. 3. The pressures at points 2 and 3 in the steam pipe are practically alike and any closing of the throttle valve will have no appreciable effect on the operation of the lubricator.

It is always desirable to connect the lubricator of an automatically controlled pump so that the oil will pass through the automatic valve and lubricate it, resulting in considerably smoother action.

One trouble often encountered in lubricators is the use of too short a drop line, 6, Fig. 3, providing insufficient condensing surface and hydrostatic head. The accompanying table issued by the Lunkenheimer Co., shows the length of drop line required for lubricators feeding various sized cylinders.

Locate the lubricator as near the steam pipe as possible so as to make the length of discharge pipe, 8, a minimum. The end of this pipe should be brought to the center of the steam line and turned downward as shown.

J. C. Long, Jr., advises M. M. to make the change suggested, having the top connection at least 18 in. above the discharge connection into the line. This will provide sufficient pressure to force the oil into the line. The altered connection will also pass the oil through the regulating valve, which will be of great benefit.

## Bent Stay Rods

TWO YEARS AGO I had the same trouble with bent stay rods, in one of my boilers, that R. C. W. inquires about. He will undoubtedly find, as I did, that the fire sheet of his boiler has sagged, probably ½ in., from the front head to the girth seam over the bridge wall, and from 2 to 3 ft. in width, thus bending the front head in below the tube line. He will also probably find that he can run the blade of his knife under the inside edge of both the head and girth seam laps, nearly to the edge of the rivets.

We were using a blast and bituminous coal, analyzing high in volatile matter. A heavy overload produced a welding heat in the furnace, and probably lifted the water from the sheet, causing it to overheat and produce a broad sag. The front head was drawn in ⅜ in., the back head remaining straight. The boiler had just been put in service, after washing out, and was cooled down at once, on account of the leak in the head and girth seams. We then found the bent stay rods.

G. H. K.

## Stopping Compound Engine

STOPPING a cross-compound Corliss valve engine at any position required is an achievement quite easy for those who are experienced, but sometimes difficult for the beginner, and only general rules applying to all kinds of Corliss engines can be given, as the proper knack of stopping can only be acquired by experience and thorough knowledge of the working of valves.

Every Corliss engine governor is fitted with a safety pin or safety collar, which ought to be put in place before shutting the throttle valve, in order, when the engine is stopped, to prevent the governor from settling to it lowest point, where it would be impossible to admit any steam and to start the engine again.

With this safety pin or collar in position, proceed to shut the throttle valve without undue haste, letting the engine speed gradually decrease until the engine is nearly stopped and the vacuum gage shows no vacuum. Then when the engine is turning slowly and just passing the head dead center, disengage the hook rod, insert the starting bar and work the valve gear in the direction opposite to its usual travel, and using proper judgment, you can stop the engine on or near the top quarter, working the gear by hand. It is advisable to have the engine on this top quarter, as this is the best position for starting again.

Cross-compound engines have an advantage over tandem engines, as usually their crankpins are at 90 deg. to each other, so that it is possible to start them either by the main throttle or by admitting steam to the receiver by means of a bypass valve usually provided by the builders, or which can be easily attached by the engineer. This bypass can be used not only in assisting to starting the engine, but also in placing the engine in position required and to serve as means of warming up and blowing out any water condensation in the low-pressure cylinder before starting.

While stopping very large engines, a clicking noise, due to valves being off the seats, is noticeable, which can be prevented by slightly opening this bypass and when the speed is sufficiently reduced, closing it again.

CHAS. BEHOUNEK.

## Incorrect Gage

FOLLOWING ARE some of the answers received to the incorrect gage problem presented by J. L. Tolman in the May 1 issue:

The oiler probably didn't remember that 1 in. of vacuum is equal to approximately 2 lb. of steam.

G. H. K.

The dial is marked wrong on the steam side, as the vacuum gage is graduated in inches of mercury which corresponds to a pressure of approximately 15 lb. The steam side should therefore be graduated accordingly; that is, to the maximum pressure of 15 lb. instead of 30 as shown. A gage of this type should also always be fitted with a siphon so that nothing but water can enter the gage tube.

CHAS. BEHOUNEK.

If the gage referred to is a vacuum gage, the pressure side should read to but 15 lb. because 2 in. of mercury are equal to a pressure of approximately 1 lb.

JOHN MITCHELL.

The right-hand side or vacuum side is graduated to 30 in., which corresponds to approximately 15 lb. pressure, while the pressure side is graduated to 30 lb. pressure or double the vacuum side. For condenser use, the scale on the pressure side should be graduated into 30 divisions, each of which would represent ½ lb. pressure.

This, however, does not necessarily signify that the vacuum side is correct. If the graduations were made by testing the pressure side, and the vacuum scale drawn exactly like the pressure scale, each division on the vacuum side will represent 2 in. of vacuum and he will not be able to get over 15 in. vacuum as read by this scale. If the scale was laid off by testing the gage from a mercury column, the graduations on the pressure side are right, but the numbers wrong and each division represents ½ lb. instead of 1 lb. as shown.

J. C. HAWKINS.

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## Breaking Away from Precedents

Knowledge of what has been done along a given line of practice is important whenever an engineer is confronted by an opportunity to take part in plant development work, but slavish adherence to precedent marks the man of mediocre ability rather than the engineer with a creative understanding of his profession. Of course, there are plenty of occasions where no departure from previous practice is justified in the solution of a plant problem, where, in fact, the engineer would be open to criticism if he recommended an unduly costly plan simply to adopt a novel program. Such might be the addition of a third or fourth generating unit to a plant already thoroughly standardized, and in which the growth of the load had proceeded along the anticipated lines, leaving no opportunity for a modification of the original scheme of development. The engineer's duty would not be performed in such a case, however, until he had made sure that since the installation of the original units the manufacturers had made no advances in design which the plant ought to avail itself of instead of merely being augmented by a "repeat order."

The above situation is not so common as might be supposed, in view of the advances being made from year to year in power plant equipment. An engineer operating a station laid out upon the basis of an elaborate report and complete design of several years back, perhaps by a consulting firm of national reputation, may be human enough to hesitate to recommend any departure from the expansion program forecasted in such a report, but he should have the courage of his convictions if he finds on investigation that new conditions demand new solutions of his employer's problems.

"John," says the plant owner on calling the chief into his office, "we've got to have some more power. The mill is growing fast and in order to make deliveries on next winter's shipments we must put in one or two more units. Here is Blank & Blank's report on the development of the station, made up at the time she was built. That provides for adding two more units of 500-kw. rating each as the load grows, and would give us a symmetrical installation. We know what those 'Speedwell' turbines will do, and I suppose we might as well call up Jimmy Turner over at the 'Speedwell' district office and get bids on a repeat order. But you might take a couple of days to look into it and then let me know what you think we ought to do before we start anything." And so it is "up to John."

John takes the report over to his little niche in the corner of the turbine room and sets to work. Probably he never knew until that moment that such a report was in existence, and it looks like a clean-cut, professional job. The presumption is in its favor at the outset. John opens the pocket at the back where the estimated load curves are filed away and immediately sees that a condition which could not be foreseen at the time the station was built, no matter how good the designing engineers were at the game, has altered the shape of the load curve actually resulting from present station service. This looks interesting, and in another half hour the chief is immersed in log sheets and diagrams, costs, outputs and loads, with his slide-rule on his desk and his loose-leaf book on station data at one side. Further study

shows that the anticipated load of the immediate future can be handled more economically by installing a 1000-kw. unit; that the fluctuations in the existing load can then be handled to more advantage with reference to the economical range of outputs of the present units worked in combination with the new one.

Now it may be that no unit larger than 750 kw. is employed in any similar industrial plant familiar to the engineer, and again that the situation demands a different type of condensing equipment for best results, perhaps a radical departure from the existing apparatus. Informal discussion with other engineers, the assembling of approximate price data from the manufacturers' representatives, and the engineer's own judgment may tell him that the time has come to recommend a change in development. If he views the problem critically, weighing each step and assumption with as much care as he can, and comes to the conclusion that his solution is the best, let him respectfully submit it to the man above. If such recommendations are backed by sound reasoning and safe assumption, the mere fact that an old report of high order recommends something else need cause the engineer no disquietude. "Be sure you are right and then go ahead," is the motto for him who would utilize precedent as a tool and who does not fear to recommend a better course when sound engineering judgment so dictates.

## Editorial Comments

Pumping water by air-lift is not a new method, but it has been looked upon with disfavor by many engineers. This is probably due to the low efficiency (around 35 per cent) which is obtained. There are, however, other considerations, such as reliability in service and maintenance costs, which may outweigh the efficiency factor and these factors are receiving more attention daily particularly by operating engineers, so that the air-lift is becoming more common and appears to be a favorite for deep well pumping, particularly where wells are scattered. The Joliet system of water works is a notable example of a successful air-lift and the description in this issue points out conditions which have made it a success where other systems have failed.

In small plants, the greatest share of the labor is in handling the coal; any sort of relief from this irksome task is heartily welcomed. Frequently, means may be installed at comparatively little cost and we are privileged to publish in this issue an article by Mr. Langworthy describing several systems which have met with success. If you are without mechanical means for handling coal and ashes it would be well to take advantage of Mr. Langworthy's suggestion and present to the "old man" some scheme for bettering coal handling in your own plant.

It is always interesting to learn of a new fuel that is available for our use. Powdered coal is so radically different in its use from any other form of fuel now used in power plant furnaces that time spent now in pondering what Mr. Harrington says in regard to it may put you among the pioneers in the successful use of this form of fuel.

Turbines present difficulties in operation which are never heard of in reciprocating engines; among these is oil and scale on the blades. The effect of this accumulation on operation and how it may be lessened and removed is told by W. E. Smith in an article in this issue.

For those who have electrical machinery to care for, several practical helps are given. Commutators are always the source of more or less trouble and Mr. Arcutt reminds you of some you may know and others which you may meet, and, what is more important, prepares you for the meeting. To operate transformers in parallel is as sensitive a job as driving a line shaft with 2 engines. It can be done, however, the "how" is told on another page.

To utilize water power of a stream that has at best a low head and at times gives no head on the water turbines was the problem presented at the Ford farms. The engineers solved this by the use of accelerator tubes and an auxiliary steam plant. The method opens a way to the conservation of our fuel resources which has heretofore been closed. Read how it was done.

Another of Mr. Solomon's interesting articles on refrigeration appears in this issue. While elementary in character, the article on brine circulating systems is written from a practical man's viewpoint, and he presents some tables that you should keep in your note book as well as facts for the head.

Like a pocket full of gold nuggets, you will find the letters direct from engineers, full of information you can use today and just as interesting as a letter from mother; just read what topics are discussed on the opposite page. There are three of these, however, that are of vital interest to us all. Governor for stoker engine control is a device the details of which we should all know and Mr. Austin presents them. The man who saves the drops saves dollars, but it must be done with judgment, and Mr. Hawkins' thoughts are worth passing on. We are apt to think of $CO_2$ as a college professor's term and suitable only to be used in a laboratory; just lay aside that prejudice, as did Mr. Wollam, and read what happened in his plant as the results of flue gas analyses.

As a rule questions and answers published in Practical Engineer, as our readers know, deal with problems concerning details of construction, operation, design, etc., which are not generally known and not found in text books. In this issue, however, the space is devoted largely to examination questions and answers, being the last of 2 series, one from Ohio the other from Massachusetts. These were chosen because the subjects treated are live issues and because many of our readers have been following courses in reading laid out especially for them by Practical Engineer last fall, and these questions serve as a review at the close of the winter's study.

Interest in Problems for Discussion is never lacking and in this issue you will find excellent rules for connecting hydrostatic lubricators from men who have met with success; also what we consider a logical reason for the bent stay rods in a boiler from a man who has had them.

Now if you have read all this you surely will be interested in the descriptions of the new and improved apparatus which follow and the opportunities offered for increasing your power plant library.

# Power Apparatus in Shop and Market

*New Ideas In Making, Buying and Selling*

## Defender Boiler Room Instruments

COMBUSTION being a chemical process, its results must be examined chemically if we are to know how nearly perfect the process has been. Once we have determined what the gas analysis should be under the conditions of the plant a study of draft losses through the boiler and flue gas temperature will show

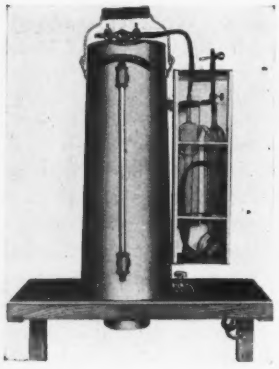


FIG. 1. DEFENDER GAS COLLECTOR AND SINGLE CHAMBER ORSAT

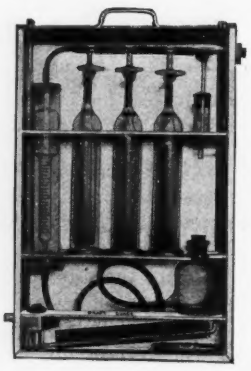


FIG. 2. PORTABLE BOILER ROOM TEST OUTFIT

a relation existing between draft, temperature and boiler efficiency so that by maintaining proper draft and temperature conditions for the load on the boiler, the fireman is reasonably sure that his combustion is taking place properly and his efficiency is high.

Instruments for analyzing gas and measuring draft losses and temperatures are essential for securing highest operating efficiency of a boiler. Recognizing this

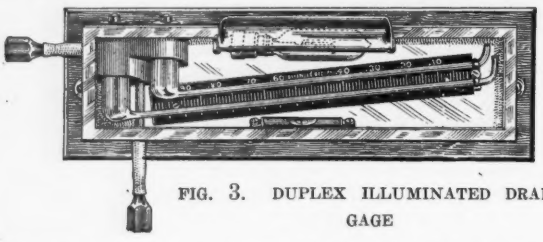


FIG. 3. DUPLEX ILLUMINATED DRAFT GAGE

fact, the Defender Automatic Regulator Co. has designed a line of instruments for doing this work which are convenient to use and accurate in their results.

The Defender Model D combination gas collector and single chamber Orsat is a convenient instrument for collecting a 12-hr. sample of flue gas and making a determination of the average $CO_2$ contained in the flue gas during the period of sampling. Salt water charged with $CO_2$ is used in the collector in order that accurate readings may be secured.

Complete analysis of flue gases, including their temperature, and a study of draft losses may be made with Defender Portable Boiler Room Test Outfit No. 2, which consists of a 3-chamber Orsat measuring $CO_2$, O and CO, a flue gas thermometer, one draft and one gas tube, a ¾-in. draft gage and all essential chemicals and connections, arranged in a single convenient portable case.

For permanent installation and continuous indication of draft losses, the draft gage shown in Fig. 3 meets the needs of the fireman. This gage has 2 tubes, the usual connection being one between the atmosphere and the furnace and the other between the furnace and the breeching. A frosted tungsten lamp with an aluminum shade lights up the scales so that they may be easily read at some distance.

## An Inexpensive Emergency Outfit

AN ingenious use of material which at first glance would seem to be valueless is shown in the accompanying illustration of a portable transformer outfit belonging to the municipal lighting plant of Crawfordsville, Ind.

This emergency outfit proved itself of great utility for testing trial power installations, break-down service and for temporary installations at country fair, and similar services.

SHOWING METHOD OF MOUNTING EMERGENCY OUTFIT

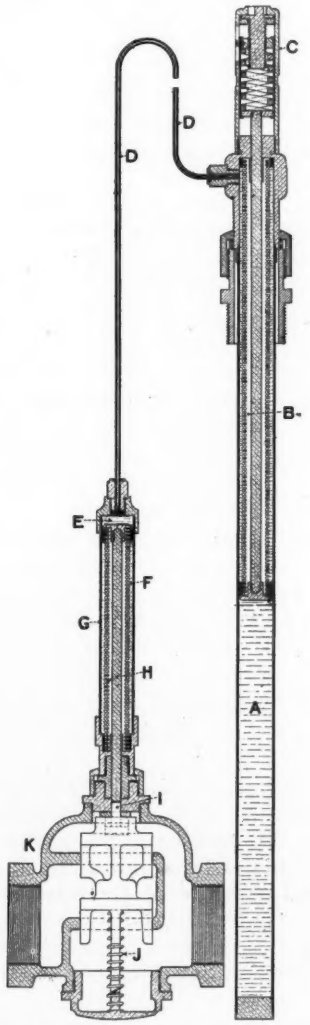
The running gear was originally part of one of the fire engines owned by the city. When the engine was scrapped, to be replaced by more modern equipment, the wheels and frame were secured by the superintendent of the electric light plant.

The electrical equipment consists of 2 Westinghouse single-phase distributing transformers, each of 25 kw. capacity. Leads are brought out to the rack so that either single-phase or polyphase current can be obtained at potentials of 110 and 220 v.

# Sarco Temperature Regulator

EXPANSION and contraction of a sensitive liquid hermetically sealed within an element is the operating principle of the Sarco Tank and Room Temperature Regulator, placed on the market by Sarco Co., Inc., of New York.

A slight increase in the temperature of the surrounding liquid or atmosphere expands the operating fluid, producing a hydraulic pressure tending to close the valve, while a decrease in the temperature produces a responsive contraction of the fluid and a gradual opening of the valve.




CROSS SECTION OF SARCO REGULATOR

The 3 principal parts of the regulator are: A, the thermostatic element which is inserted in the boiler or tank; G, the controller element, and K, the valve. The sectional view herewith shows the construction. Thermostat A is a tubular receptacle containing a heavy hydrocarbon oil, the expansion and contraction of which, due to temperature changes, is used to actuate the balanced valve, K, through the controller element, G. A and G are in communication through D, a fine bore, heavy-wall copper tube, the whole forming a closed system, hermetically sealed.

In the thermostat is a corrugated tube, B, the length of which is controlled by the adjusting screw, C. This tube serves to vary the temperature at which the regulator valve operates, this being accomplished by changing its length in the thermostat. If its length is increased, the oil will have less space for expansion and consequently the valve will be operated at a lower temperature. If its length is diminished by turning the regulator head, the valve operates at a higher temperature. Controller G contains corrugated tubing, F, which is exposed to the expansive force of the liquid and thus acts through piston H to move valve stem I and open or close the valve as may be desired.

Spring J is opposed to the direction of expansion and tends to keep valve K open.

These regulators operate steam, water or gas valves, and can be supplied with reverse valve to open with rise of temperature.

# American Ass'n of Engineers

ON MAY 9 and 10, the first annual convention of the Association was held at the rooms of the Western Society of Engineers in Chicago, the work being limited to a review of what was accomplished during the first year of the existence of the society and to discussions of ways and means of promoting its objects. A student membership was provided to be offered to engineering students of accredited schools, the annual fee being $3, $1 of which is used for subscription to The Monad, the publication of the Association.

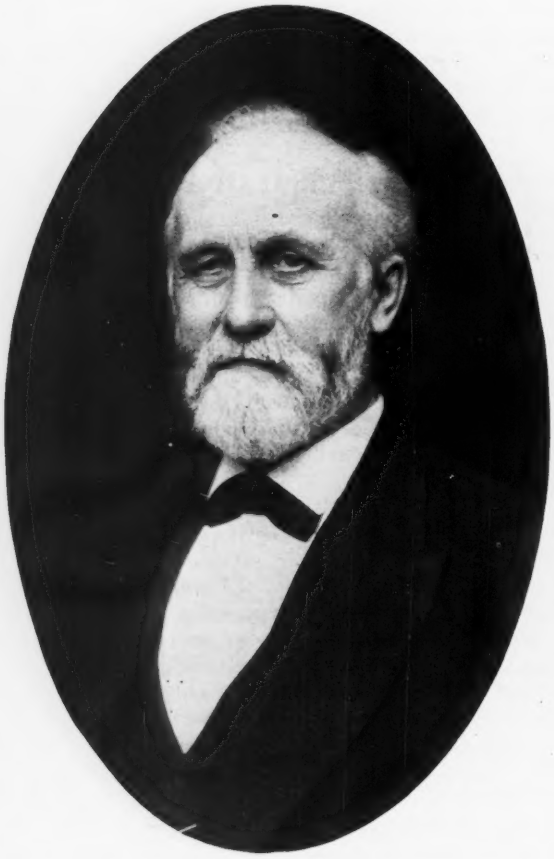
Resolutions were adopted calling upon the government for blank forms for registering the qualifications of engineers, so that their services may be used, if needed, where they will be of the greatest value, rather than having highly trained men enlist as privates. The resolutions also call upon the government to co-operate with the various engineering societies instead of leaving the societies to take the initiative and bear all expenses connected with patriotic work without any kind of government support. As the need for military maps of the country was clearly brought out, a committee was appointed to make a study of this matter and make recommendations as to how the American Association may be of assistance.

The secretary reported 700 members, of whom 400 reside in and near Chicago and the remainder in other cities, in this country and abroad. Since Sept. 15, 350 positions have been offered to members and other engineers, and assistance has been given in warning engineers against applying for positions which require the purchase of stock to secure a large salary. Expenditure of the Association during the year has been less than $4,000, about one-half of this being used in the Service Clearing House Department, which handles the employment feature. Officers elected for the coming year were: President, Garrison Babcock; Vice-President, T. B. Lambert; Secretary, Arthur Kneisel; Treasurer, O. F. Gayton; Directors, A. H. Krom and W. J. Mauer. The Association has taken new and enlarged national headquarters, Rooms 601-4, 29 S. La Salle St., Chicago.

# John Edson Sweet

JOHN EDSON SWEET, known throughout the country as an exponent of applied science, died at Syracuse, N. Y., on May 9, at the age of 83.

Dr. Sweet was born at Pompey, N. Y., Oct. 21, 1832, and grew to school age on his father's farm. Between 7 and 15 yr. of age, he obtained what education the district schools offered, and when it became apparent that his ambitions lay along mechanical lines, he was apprenticed in 1850 to a carpenter. Out of his wages of $7 a month he soon managed to save enough to go to Syracuse where he studied draughting in the office of an architect while working as office boy.



In 1859 he decided that opportunities were greater in the South and spent 2 yr. as architect and builder in Alabama, then returning to Syracuse at the outbreak of the war, took a position as draughtsman and pattern maker in the railroad shops. In the summer of 1862 he went to Europe, and after traveling about for a short time, obtained a position in a patent office in London.

As his knowledge of mechanics developed, Dr. Sweet's mind turned to invention. His first effort was a nail machine upon which he received a patent. As the Patent Nut and Bolt Co., of Birmingham, England, took an interest in the machine, he went to the company shops and worked as a daughtsman while superintending the construction of his machines. Returning to Syracuse in 1864, he took a position as designer and draughtsman with Sweet, Barnes & Co., and later became superintendent of the works.

Following his marriage in 1870 to Miss Caroline V. Hawthorne, he was for 3 yr. engaged in bridge building for Howard Soule of Syracuse, during his leisure hours drawing plans and making patterns for what was to be the first Straight Line steam engine.

It was in 1873 that Dr. Sweet joined the faculty of Cornell University as Professor in engineering at Sibley College, and the manner in which he developed the mechanical abilities of his students under discouragements due to lack of equipment and sympathy from those then in authority at the University, was one of his greatest accomplishments.

In 1879 he resigned from Cornell University, and having perfected his engine, began its manufacture in a modest way. The Straight Line Engine Co. was organized, with Dr. Sweet as president and general manager, and as the new type of engine found advocates all over the country, the business steadily increased, although Dr. Sweet operated always upon the theory that to build a few engines and build them right, was better than to flood a big market with a less worthy product.

It has been said of Dr. Sweet that he was the widest known mechanical engineer in the United States, this apparently broad statement being based upon the fact that he personally knew more men and was known by more men in his profession than any other living engineer. This was due to his contributions to mechanical development, his work exhibited at expositions, his travel abroad and his employment there.

His notable honors begin with his election as president of the American Society of Mechanical Engineers in 1883. He was selected as government expert and one of the jurors on machine tool awards at the Chicago Exposition in 1893; was the first president of the Engine Builders' Association of the United States, 1899 to 1901; president of the Syracuse Metal Trades Association from 1906 to 1907; and president of the John Fritz Medal Association in 1906.

In 1914, Syracuse University conferred upon Dr. Sweet the degree of Doctor of Engineering, this being the third time that such honor was conferred on a man in the United States by any institution. Perhaps the highest honor bestowed upon Dr. Sweet was the award to him of the John Fritz medal at the thirty-fifth annual meeting of the American Society of Mechanical Engineers, of which Dr. Sweet was one of the founders.

Cut in stone over the main entrance to the Straight Line Engine Works was the motto, "Visitors Always Welcome." This is characteristic of Dr. Sweet's hospitality and willingness to assist others, particularly young men anxious to make progress in engineering fields.

It may truly be said that Dr. Sweet exercised a greater influence on technical men than any other man of his generation. As a man and an engineer his was a useful, upright life, and his memory will remain long as an incentive to those who were favored by knowing him.

# News Notes

THE INDUSTRIAL CONTROLLER Co., of Milwaukee, Wis., has recently appointed Geo. W. Lyons district manager, with offices in the Monadnock Block, Chicago, Ill.

THE TERRY STEAM TURBINE Co., Hartford, Conn., announces the appointment of O. E. Thomas, 626 Washington Bldg., Los Angeles, as District Sales Manager, for a territory covering Arizona and the southern portions of California and Nevada.

THE PILLEY PACKING & Flue Brush Mfg. Co., of St. Louis, Mo., has opened an eastern branch office at 71 Fulton St., New York City. This has been made necessary owing to the increase of business in this district and the eastern office will be able to accommodate these customers with better and quicker service. The office will be open for business June 1, and carry a complete line of material now made at the St. Louis factory, including a stock of packing, flue brushes, hot water and steam heater brushes, steel wire brushes and brooms and engineer's tools.

A STRIKE OCCURRED, April 21, at the East Pittsburgh Works of the Westinghouse Electric & Mfg. Co. No reason was given, as no grievances had been handed in to the Standing Committee representing both the company and employes. It has developed, however, that the principal demand is for an 8-hr. working day, and it is understood that a communication was later sent to the management of the company demanding a reduction of the working hours from 52 to 48 hr. a week, with no reduction in wages—this in addition to a 10 per cent advance in wages recently granted all shop employes. The Westinghouse Electric & Mfg. Co. is known to be committed as opposed to a reduction of working hours at the present time.

CALLING ATTENTION to the unfortunate condition that, through discontinuance of trading on the New York Metal Exchange, the prices of copper, lead, tin and spelter are made in London, and that owing to the demoralized condition of the London market the values so fixed do not express any relation of supply to demand, The Daily Metal Reporter appeals to Secretary W. C. Redfield in an open letter, asking as a relief that trading on the New York Metal Exchange be re-established.

The United States is the leading producer of copper, and there seems no logical reason why the price should be fixed in London. Active, healthy trading in New York would serve to make this country the recognized metal market of the world, and the opportunity now seems open to secure this advantage.

WITH 6 cities joined by long distance telephone, and each of the 6000 members scattered in meetings from the Atlantic to the Pacific provided with a telephone instrument, a national meeting of the American Institute of Electrical Engineers was held on May 17.

In New York, brief addresses of the officers, and greetings from Alexander Graham Bell, Theodore N. Vail, and other members instrumental in the progress of the telephone, were heard distinctly by the members assembled in Atlanta, Boston, Chicago, San Francisco, and Philadelphia.

This is the first meeting conducted by a national organization in which the widely scattered sections were in complete touch with each other throughout the entire proceedings. The success of this unique procedure is evidence of the inventive genius and engineering ability of the telephone engineer, and opens up broader possibilities for the long distance telephone.

# Catalog Notes

ANNOUNCEMENT IS MADE of the new catalog just issued by The Graton & Knight Mfg. Co., oak leather tanners and belt makers, Worcester, Mass. It is a fine specimen of what a catalog of this nature should be, for besides illustrating and describing all the products made by this company, much space is devoted to facts of general interest to those who purchase belting, lace leather, packings and other leather products.

The Belting Section of the catalog is of unusual interest to buyers of belting, as it not only describes the characteristic qualities of each grade manufactured, but also explains clearly and conclusively why these grades are essential, their particular differences and capabilities. This section also embodies valuable mechanical rules,

tables and formulas, to assist the buyer to determine the proper grade, width and weight of belting required for any given drive.

A special section of the catalog is devoted to Leather Packings, describing all the various kinds, grades and the advantages of each. The company makes all kinds of straps, automobile leathers, halters and other leather sundries, and these are illustrated and described in the section devoted to this department.

A copy of this catalog will be sent upon request to executives, purchasing agents, engineers and others interested in the buying of belting and other leather products.

"SARCO TEMPERATURE CONTROL" is the title of a new pamphlet received from Sarco Company, Inc., of New York, describing its tank and room temperature regulators. Operation of the regulators is based upon the expansion and contraction of a sensitive liquid hermetically sealed within the elements; the same thermostatic principle that is employed in the action of the Sarco steam trap.

TO THOSE who wish to refer forward and backward to the dates of various years, a 3-year calendar issued by the National Tube Co. will be found convenient. This has on the first page, an artistic design, on 2 succeeding pages, some views of exhibits which secured notable prizes and recognition at the Panama-Pacific International Exposition, and the fourth page gives complete calendars for the years 1916, -17 and -18.

National Tube Co., Frick Bldg., Pittsburgh, Pa., will be glad to send one of these calendars to anyone whose activities call for legitimate use of the National Tube Co.'s products.

"WHAT THE SPRAY Engineering Co. Has Done and Is Doing," is the title of a small booklet just issued, which contains a fairly complete list of the cooling pond and air washer installations in 35 states, Canada, Mexico, Cuba and So. Africa, of the Spray Engineering Co., of Boston, Mass.

## Trade Notes

IN THE prize article contest conducted by the Diamond Power Specialty Co., of Detroit, which closed April 15, $100 in cash prizes were offered for the 4 best articles on mechanical soot blowers. The entry list was large and included articles from all parts of the U. S. and Canada.

Winners of the first 3 prizes are consulting engineers. The first prize of $50 went to Phineas V. Stephens, Morris Ave., New York City. His subject was "What the Mechanical Soot Blower Has Done Toward Greater Economy and Efficiency in the Power Plant." The second prize of $25 was awarded to Reginald Trautschold, of New York City. His choice of subject was the same as the first prize winner. Third prize of $15 went to H. E. Weightman, consulting engineer, of Chicago. His subject was "Why I Endorse the Use of Mechanical Soot Blowers." The fourth prize of $10 was won by Arthur Kirby, Chief Engineer, of the Warren Light & Power Co., Warren, Pa. His subject was "The Mechanical Soot Blower vs. the Hand Method." Honorable mention is given to C. W. Howard, Power Plant Superintendent, of the General Electric Co., Erie, Pa., and to C. D. Lewis, Chief Engineer of the Morrell Packing Co., Ottumwa, Iowa.

The contest has attracted so much attention among engineers that it will probably be made an annual affair. The articles will be published in booklet form and will be ready for distribution soon.

THE DEPARTMENT of Mechanical Engineering of the University of Illinois has just received from the Crane Co. of Chicago an unusually complete and attractive exhibit of the product of this company. It includes a number of very large valves, steam traps and other power specialties mounted on polished cast-iron floor pedestals, together with an oak display case mounting samples of the smaller valves, fittings and specialties.

WESTINGHOUSE Electric & Mfg. Co., of East Pittsburgh, Pa., has sold to the Brooklyn Rapid Transit Co. 1 30,000-kv.a. turbo-generator unit and one 40,000-sq. ft. condenser; to the Berwind White Coal Co., 6 13-ton locomotives each equipped with 2 No. 908 ball bearing motors and 2 35-ton locomotives with a 3 No. 909-C ball bearing motor equipment.

PRACTICAL ENGINEER

Trade-mark. Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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### Display

Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year each insertion, $20.00.

Eighth page, one year, each insertion, $12.00.

Front cover $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Advertisements in this section are inserted under regular headings.

### Classified Rates

Per line, 30 cents each insertion.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

**Technical Publishing Co.**

537 S. Dearborn Street

Chicago

**Position Wanted**

POSITION WANTED—As master mechanic or assistant; 21 years' experience. Had charge of erecting, repairing heavy duty engines, machinery and mixed blow turbines. Expert on lubricants. Address Practical Engineer, Box 435, Chicago, Ill. 5-15-1

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 5-15-1

POSITION WANTED—License chief engineer wants change; 12 years' experience in manufacturing and central stations, steam electrical, refrigeration and producer gas, high speed and Corliss engines, condensers, etc. Age 32, American and married. Address Box 437, Practical Engineer, Chicago, Ill. 4-1-4

POSITION WANTED—By chief engineer, 35, married. Use no liquor; 15 years' experience, electrical and refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Practical Engineer, Box 436, Chicago, Ill. 3-15-4

POSITION WANTED—Young man wants position as helper, extra engineer or fireman. Two years' practical experience. I. C. S. student. Write Rasmus Stenner, 300 Fremont St., Portland, Ore. 5-15-1

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by leteers. Write to W. D. Bellesfield, Rock Valley, Iowa. 5-15-1

WANTED—Position as engineer in pumping station or in some stationary plant. I have had 4 years' experience in engineering. What have you to offer? E. W. Adkins, Charleston, Ill. 4-15-3

POSITION WANTED—Inside of power plant by young man with a technical education, but no experience. For particulars write to K. Lufter, Kewaunee, Wis. 5-15-1

MANUFACTURERS' OPPORTUNITY to obtain the services of thoroughly A1 Engineer as Chief or Supt. of Power. A genuine offer of quality services, by a well experienced and technical trained man. This is not a bargain sale; it is a quality offering of established value. Investigation welcomed. Address Practical Engineer, Box 439, Chicago, Ill. 6-1-1

## Help Wanted

WANTED—Resident subscription agents in the following cities: Altanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago tf.

## Wanted

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents to handle Chemicals for Boiler Rooms, Laundries and the Automobile Trade. Strictly commission basis. State age and experience. Address Practical Engineer, Box 440, Chicago, Ill. 6-1-6

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

## For Sale

FOR SALE—Second-Hand Machinery.. One Hamilton-Corliss engine 22x48, A1 condition. One 15-inch Fay-Egan band resaw and grinder. One 10-inch Fay-Egan 4-sided moulder. One 6-inch H. B. Smith 4-sided moulder. One Fay-Egan sash tenonner with double cope knives and cut-off saw. One 30-inch heavy cabinet planer (Whitney), with sectional feed rolls and sectional chip breaker. All above in first-class condition. The Vinton Company, Detroit, Mich. 6-1-2

TEN D. C. 220 VOLT MOTORS, 5 to 55 hp. Send for list. Lucas & Son, Bridgeport, Conn. 6-1-2

FOR SALE—1 85 KW. General Elec. 3 Phase, 4 Wire, 110-220 Volt, 60 Cycle, Belt Driven Generator and 2 Panel Switchboard with 1 Voltmeter, 3 Ammeters, 7 Quick Break Double Throw Switches, Exciter Rheostat and 4 Pt. Test Switch, all Wagner make. One 14¼x24 Buckeye Engine, 150 R.P.M., 125 HP. at 100 lb. pressure. Maximum HP. 165 with 63 ft. of 14-inch Belt. All in good condition. Fine for small town plant. Will sell complete or separate. One 14x36 E. P. Allis Corliss Engine, 100 HP., 100 R.P.M., Cylinder rebored, new piston and thoroughly overhauled one year ago. Good as new. Some 8-inch and 10-inch Lunkenheimer Valves and 8-inch Flanged L's and T's. Two 1¼-inch Crane Tilt Traps, almost new. Will sell above at a bargain. Dubuque Brewing & Malting Co., Dubuque, Iowa. tf.

FOR SALE—Two 1040-hp. horizontal, cross-compound heavy duty, mill type, Buckeye engines, 24x42x36, 120 r.p.m.; each direct connected to 500-kw., 250-v. Westinghouse Type "Q" generators. Excellent condition; good as new. Now in operation. If interested, write for full information and prices. Box 197, Elyria, Ohio. 4-15-4

## Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F. St., N. W., Washington, D. C. tf.

PATENTS—C. L.' Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F. St,, Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F. St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

## Technical Books

ENGINEERS AND FIREMEN—Send 10c in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2238-A Pope Ave., St. Louis, Mo. E.O.I.-tf.

## Miscellaneous

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

# *Sparks From The Advertising Pages*

## Are You Working WITH or Only FOR Your Company

Co-operation is one feature of your business organization upon which you cannot place too strong a stress. All petty jealousies and personal grievances fade away before hearty, wholesome and willing co-operation. Your plant can be either highly efficient or decidedly unprogressive—it can be either extremely economical or extravagantly wasteful.

And that all depends upon **YOU**—whether you are oiler, fireman, engineer or chief.

If you are lackadaisical, or slip-shod and and careless—your work will show it and you, yourself, will pay the penalty.

Such a simple thing as putting tools back into their proper place is a practice that is often neglected and in many plants results in a loss that represents a neat little sum annually.

Team work is what the baseball fan calls organization and co-operation on the diamond, and if it is important there, it is manifoldly important in the business world.

Then again—if every member of your power plant staff is interested only in his own plant, you have a localized organization—and with it you cannot get the most out of the plant. Your own efficiency depends upon the experience of others—and the very plant you are operating, most likely represents the practice of those who have been so successful that you or your consulting engineer have followed their example. Therefore, it, behooves every unit of your system to get interested in other plants as far as equipment and organization are concerned.

When a device is advertised that has proved to be a saving factor in good engineering practice it is a wise move to investigate it.

The chief should not be the only one who knows equipment—all connected in any way with power plant operation should be familiar with what the manufacturers are offering.

It is the employes who are working **for** and not **with** their employers who believe suggestions now and then are out of order—when instead, they are, in the great majority of instances, most welcome. Of course, they must be concrete, workable plans that will bear keen analysis.

A good course to pursue to stimulate these ideas is to study the advertising pages, find out the equipment that is applicable to your plant—get in touch with the manufacturers and get lists of installations. You will very likely find some close to your own plant and when you have investigated and found out their efficiency and economy—you can make a real worth-while suggestion that will be welcomed by the chief, or if you are the chief, you can present it to the management.

Your investigation will make you a better power plant man, whatever your position may be.

Reading the advertisements will not make you an engineer 'tis true—but you'll be a mighty poor one, even though you take mechanical degrees galore, if you **do not know** what the manufacturers of modern engineering equipment and supplies have to offer.

The advertisements tell the why and wherefor of mechanical products which must do what the advertisements say or they would not be advertised in Practical Engineer.